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AUDITABLE SAFETY ANALYSIS
FOR
THE EFFLUENT TREATMENT FACILITY (U)

(S-TRT-H-00001)

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ORIGINAL

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Patent Status

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SRS

Westinghouse Savannah River Company
Aiken, SC 29808

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-96SR18500

DISCLAIMER

Revision Record

Revision	Date	Revision Description
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1	June 1999	Incorporated S-DCF-H-00046
2	November 1999	Incorporated S-DCF-H-00054
3	February 2000	Incorporated S-DCF-H-00058
4	May 2000	Incorporated S-DCF-H-00065
5	December 2000	Incorporated S-DCF-H-00080
6	November 2001	Incorporated M-DCP-H-01009-DCN S-001, S-DCF-H-00088 and S-DCF-H-00091
7	September 2003	Incorporated S-DCF-H-00102, J-DCF-H-03768, N-NCS-H-00132, and comments from annual review.
8	October 2004	Incorporated M-DCF-H-09748, S-DCF-H-00133, and comments from annual review.

CONTENTS

ACRONYMS AND ABBREVIATIONS

AN	Aluminum Nitrate
AOP	Abnormal Operating Procedure
ASA	Auditable Safety Analysis
BOD	Biochemical Oxygen Demand
CBU	Closure Business Unit
Ci	Curie
CIF	Consolidated Incineration Facility
CONOPS	Conduct of Operations
CRO	Control Room Operator
DCS	Distributed Control System
DOE	Department of Energy
DSA	Documented Safety Analysis
EAL	Emergency Action Level
EOP	Emergency Operating Procedure
EPHA	Emergency Preparedness Hazard Assessment
EPIP	Emergency Plan Implementing Procedure
EPZ	Emergency Planning Zone
ERPG	Emergency Response Planning Guide
ETF	Effluent Treatment Facility
ETP	Effluent Treatment Project
FN	Ferric Nitrate
FHA	Fire Hazards Analysis
FHC	Facility Hazard Category
FOSC	Facility Operations Safety Committee

ACRONYMS AND ABBREVIATIONS (continued)

HA	Hazard Assessment
HASP	Health and Safety Plan
HDP	H-area Disposition Project (formerly H Tank Farm)
HEPA	High Efficiency Particulate Air
HLW	High Level Waste
HLWO	High Level Waste Operations
HVAC	Heating, Ventilation, and Air Conditioning
IDLH	Immediately Dangerous to Life and Health
IOP	Integrated Operating Procedure
IX	Ion Exchange
JHA	Job Hazards Analysis
LWDP	Liquid Waste Disposition Projects
MSB	Management of Safety Basis
NCSE	Nuclear Criticality Safety Evaluation
NDE	Non-Destructive Examination
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NPH	Natural Phenomena Hazard
NPSH	Net Positive Suction Head
OR	Organic Removal
OSHA	Occupational Safety and Health
P/C	Physical/Chemical
PHR	Process Hazards Review
PM	Preventive Maintenance
PPE	Personal Protective Equipment

RCO	Radiological Control Operations

ACRONYMS AND ABBREVIATIONS (continued)

RMA	Radioactive Material Area
RO	Reverse Osmosis
RQ	Reportable Quantity
RWP	Radiation Work Permit
SCDHEC	South Carolina Department of Health and Environmental Control
SDG	Standby Diesel Generator
SOP	Standard Operating Procedure
SRS	Savannah River Site
SWMF	Solid Waste Management Facility
SWD	Solid Waste Division
TPQ	Threshold Planning Quantity
TQ	Threshold Quantity
USQ	Unresolved Safety Question
UTRC	Upper Three Runs Creek
WAC	Waste Acceptance Criteria
WCP	Work Clearance Permit
WCT	Waste Concentrate Tank
WSMS	Westinghouse Safety Management Solutions
WSRC	Westinghouse Savannah River Company
WWCT	Wastewater Collection Tanks

EXECUTIVE SUMMARY

The Effluent Treatment Facility (ETF), at the Savannah River Site, is classified as an "A" Level physical/chemical wastewater treatment facility by the South Carolina Department of Health and Environmental Control. Based on an in-depth assessment of the radiological and chemical inventories as documented in the Hazard Baseline Downgrade [1], the ETF was downgraded from a "Hazard Category 3 Facility" to a "Radiological/ Low Hazard Chemical Facility". The assessment was performed in accordance with Westinghouse Savannah River Company Manual 11Q [2], DOE-STD-1027-92 [3], and DOE-EM-STD-5502-94 [4]. DOE-EM-STD-5502-94 states that "...all radiological facilities shall develop an auditable (defendable) safety analysis (similar to a SAR but with significantly reduced content and requirements)". The terms "ETF" and "ETP" are used somewhat interchangeably in this document due to changes in organizational nomenclature. The term "ETF" is used only within the title of this document, this executive summary, and at selected locations where it is necessary in an historical sense or convenient to distinguish between the systems, structures and components closely linked to the main process (as opposed to outlying facilities such as the basins associated with the project). The term "ETP" is utilized whenever possible. The Auditable Safety Analysis shall:

- Provide a systematic identification of the safety and health hazards associated with operation of the ETP,
- Qualitatively discuss the programs that evaluate and control these hazards to ensure the protection of ETP employees, the offsite public, and the environment,
- Address the required engineering controls, administrative controls, and work practices, which minimize these hazards.

DOE-EM-STD-5502-94 further states that "Radiological" facilities that routinely conduct hazardous waste activities also require the development and maintenance of a Health and Safety Plan. Even though potentially releasable radioactive material above the quantities defined by 40 CFR 302.4, Appendix B [5] may be present at the ETP, hazardous waste operations as defined by 29 CFR 1910.120(a)(1) [6] are not performed at the facility. Hence, it was determined that a HASP is not required for the ETP.

The goal of this ASA is to demonstrate that the processes and equipment utilized at the ETP can be operated without undue risk to the onsite and offsite populations or to the environment. This ASA revision supersedes all previous Safety Basis Documents for the ETF / ETP.

1.0 INTRODUCTION

The purpose of the ASA is to provide a systematic identification of hazards within the ETP operation and to describe the measures taken to eliminate, control, or mitigate the identified hazards. Based on a Hazard Assessment, a total of 87 potential events were identified and evaluated. Because of the limited energy sources of the liquid wastes from ETP, release pathway and exposure mechanisms of the wastes are limited. As a result of this analysis, the highest consequence classification for the ETP due to the potential events was determined to be a minor facility impact. Risks of the consequences from all the postulated events were found to be within the SRS evaluation guidelines. Therefore, this ASA demonstrates that the ETP can be operated without undue risk to the onsite or offsite populations or to the environment.

The ASA comprehensively identifies potential events, their initiators, and the features to prevent or mitigate the events. This document contains discussions on the following elements:

- Hazards associated with the operations [36]
- Determination of and adequacy of controls (Sections 3 and 4)
- ASA Maintenance (Section 6)

1.1 FACILITY HISTORY AND DESCRIPTION [7, 8, 9, 10]

The ETP, located in H Area (see Figure 1.1-1), collects and treats process wastewater, which may be contaminated with small quantities of radionuclides and process chemicals. The acronym "ETP" (Effluent Treatment Project) may also be used to describe both the facility and its supporting infrastructure. The primary sources of wastewater include F-Area and H-Area Canyon / Outside Facilities, F-Area laboratories, and F/H Tank farm evaporator overheads. Other miscellaneous sources include the Scavenger Waste Program and approved influents that meet the ETP Waste Acceptance Criteria [11]. All deviations from the WAC shall be evaluated by ETP Engineering and approved by the ETP Project Manager. The wastewater is treated to National Pollutant Discharge Elimination System standards. The facility, which has been in operation since October 1988, was designed to operate at an average capacity of 165 gpm and with a "sprint capability" of 300 gpm for short durations. Based on the effectiveness of the treatment, 99% of the wastewater may be discharged to the environment. The ETP process can be broken down into the following distinct and numbered segments:

1. F-Area Cooling Water Basin and adjacent RMA
2. F-Area Retention Basin and adjacent RMA
3. H-Area Cooling Water Basin and adjacent RMA
4. H-Area Retention Basin and adjacent RMA
5. Lift Stations, Force Main, Wastewater Collection Tanks, Organic Removal System Mercury Removal and Activated Carbon Columns, and Cold Chemical System Storage Tanks

6 Treatment Building, Control Building, Other Outside Tanks, Outfall at Upper Three Runs Creek , and High-Efficiency Particulate Air units

7 Waste Storage Area east of the Treatment Building

The general location of the ETP is presented in Figure 1.1-1, which also identifies the various waste generators and flow paths associated with the facility and shows primary sampling points. A simplified block diagram of the ETP process flowpath and segmentation is shown in Figure 1.1-2. A plot plan showing the location and inter-relationship between the major ETP components and unit operations is shown in Figure 1.1-3.

1.1.1 SEGMENT 1: F-AREA COOLING WATER BASIN AND RMA

The F-Area cooling water basin (241-97F) is a flat-bottomed, sloped-wall, double-lined, impermeable, earthen storage basin with a nominal holding capacity of 5.0 million-gallons. The purpose of this basin is to receive diverted, circulated or segregated cooling water from the F-Area Canyon. The basin is segregated into a 1.4 million-gallon high contaminated section and a 3.6 million- gallon moderately contaminated section. If the total volume of the diversion exceeds 5,000,000 gallons, the excess water is diverted to the retention basin (Segment 2). The basin is equipped with three transfer pumps located inside a pump pit. These pumps provide the ability to transfer the collected cooling water directly to an NPDES outfall going to Four Mile Creek or to the ETF via the lift stations (Section 1.1.5). Sump pumps are also provided to pump-out the basin inlet structure, the high and moderate stilling wells, and the pump pit sump as required. Any water collected in the leak detection sumps is transferred to the high contaminated section of the basin. A standby diesel generator (SDG 254-8F) distributes backup power to essential equipment in the F-Area cooling water basin upon loss of normal power.

Loss of the cooling water basin would result in diversion to the retention basin via the cooling water diversion box. This could ultimately restrict or suspend the 200-Area Separations Department operations. Continued operation of this facility without the capability of storing and transferring the resulting circulated or segregated cooling water could result in an environmental release of contaminated water.

Portable de-ionizers and/or any waste package containing basin sediment or spent resin stored within the segment are to be considered in the segment inventory. Job control waste packages are not included in the inventory.

1.1.2 SEGMENT 2: F-AREA RETENTION BASIN AND RMA

The F-Area retention basin (281-8F) is a flat-bottomed, sloped-wall, single-lined, impermeable, earthen storage basin with a nominal holding capacity of 11 million-gallons. The purpose of this basin is to receive contaminated or potentially contaminated storm water runoff from the F-Area Tank Farm and any diverted cooling water in excess of the 5,000,000 gallon capacity of Segment 1. The basin is equipped with two transfer pumps, that provide the ability to transfer the contents of the basin directly into an NPDES outfall going to Four Mile Creek or to the ETF via the lift stations (Section 1.1.5). The F-Area retention basin does not receive backup power from SDG 254-8F upon loss of normal power.

Loss of the retention basin could result in an environmental release of contaminated water.

Portable de-ionizers and/or any waste package containing basin sediment or spent resin stored within the segment are to be considered in the segment inventory. Job control waste packages are not included in the inventory.

1.1.3 SEGMENT 3: H-AREA COOLING WATER BASIN AND RMA

The H-Area cooling water basin (241-103H) has the same function as the F-Area cooling water basin, Segment 1 (Section 1.1.1). The primary difference between the H and F Area configurations is that the H-Area basin has screw pumps, with a leak detection sump, to provide the lift necessary for the diverted cooling water to enter the cooling water basin inlet structure. The nominal basin capacity is 2.7 million gallons, with 0.7 million gallons in the high contaminated and 2 million gallons in the moderately contaminated sections. SDG 254-8H distributes backup power to essential equipment in the H-Area cooling water basin upon loss of normal power.

Portable de-ionizers and/or any waste package containing basin sediment or spent resin stored within the segment are to be considered in the segment inventory. Job control waste packages are not included in the inventory.

1.1.4 SEGMENT 4: H-AREA RETENTION BASIN AND RMA

The H-Area retention basin (281-8H) has the same function as the F-Area retention basin, Segment 2 (Section 1.1.2). The basin has a nominal capacity of 8 million gallons.

Portable de-ionizers and/or any waste package containing basin sediment or spent resin stored within the segment are to be considered in the segment inventory. Job control waste packages are not included in the inventory.

1.1.5 SEGMENT 5: LIFT STATIONS, FORCE MAIN, WASTEWATER COLLECTION TANKS, ORGANIC REMOVAL SYSTEM (MERCURY REMOVAL AND ACTIVATED CARBON COLUMNS), AND COLD CHEMICAL SYSTEM STORAGE TANKS

Segment 5 includes the Lift Stations, Force Main, the Wastewater Collection Tanks, and a cold chemical storage area. The mercury removal and carbon adsorption columns for the Organic Removal system are also located in this segment, adjacent to the Wastewater Collection Tanks.

1.1.5.1 Lift Stations and Force Main

Each F/H Area lift station includes a nominal 65,000-gallon collection tank, two transfer pumps, and a sump pump. Process Sewers (gravity drains) leading to the lift stations are considered empty for the purposes of segmentation and inventory control. The transfer pumps operate in a lead and lag configuration, and normally start and stop automatically based on collection tank level. Essential equipment at the F-Area Lift Station and H-Area Lift Station receive backup power from SDG 254-8F and 254-8H respectively. Wastewater is pumped from the lift station through a force main valve pit to the ETF Wastewater Collection Tanks or to the H-Area Tank Farm via a diversion box (HDB-8), through buried transfer lines. Leak detection equipment, located in manholes at low points in the transfer lines; provide the capability to check transfer line integrity. The wastewater could be diverted to HDB-8 if contamination exceeds the limits established in Reference 11. The flowpath from the force main to HDB-8 is currently disabled by the installation of pipe blanks. A design change would be required to utilize this flowpath. Loss of the lift stations, transfer pumps, or force main could immediately restrict or suspend operation of affected upstream wastewater generating facilities in the 200-F/H areas. Continued operation of these facilities would result in an environmental release of contaminated water.

1.1.5.2 Wastewater Collection Tanks /Pretreatment System

The WWCTs at the ETF consist of two nominal 485,000 gallon tanks and two wastewater feed pumps, contained within diked areas. When a sufficient volume of wastewater is available for processing, a chemical pretreatment (pH adjustment, flocculant addition) of the wastewater is performed in the WWCTs. The pH of the wastewater is adjusted to a range of 1.5 – 2.5 to keep dissolved metals (sludge) from precipitating out of the solution. A flocculant, aluminum nitrate, is added to the wastewater, which reacts with bacteria and suspended particles in the wastewater to form larger particles. This flocculant addition reduces fouling and optimizes efficiency of the ETF filtration system filters (Section 1.1.6.2). Flow from the WWCTs is routed through one of two basket strainers, which removes any debris/large particles present in the wastewater.

Loss of the WWCTs and Pretreatment System will result in an inability to receive and store process wastewater from the lift stations. This could result in an environmental release of contaminated water due to lift station/basin overflow. The 200-F/H Area operations would be restricted or suspended.

1.1.5.3 Organic Removal System

The OR System removes heavy metals (mainly mercury) and organics (mainly tributyl phosphate) from the wastewater to prevent fouling of the Reverse Osmosis membranes. The OR System is located after the ETF Filtration System and prior to the ETF RO System in the process flowpath (see Figure 1.1-2). The OR System carbon columns, mercury removal ion exchangers, cartridge filters, and related components are physically located outside of the Treatment Building adjacent to the WWCTs within concrete diked areas to contain any wastewater leakage. The OR System consists of a 5,400 gallon feed tank, two feed pumps, three mercury removal columns, three activated carbon columns, two cartridge filters, a caustic cleaning tank for the mercury columns and cartridge filters, and a dewatering tank. Note that the feed tank and feed pumps are physically located in Segment 6. The transfer pump provides the motive force through the OR System components and to the RO pH adjustment tank. The three mercury removal columns are filled with ion exchange resin which absorbs mercury and some other heavy metals that may be present. The column differential pressures, as well as samples of the column effluent, are used to monitor resin loading. Chemical cleaning or resin replacement is based on column differential pressure and sample results from the columns. A cleaning tank and piping to recirculate a dilute caustic solution through the organic removal columns provides a method for mercury removal column cleaning operations.

Two activated carbon columns are routinely operated in series with the third column on standby. The columns are filled with Granular Activated Carbon, which removes organics. The influent and effluent of each column are periodically sampled and analyzed to determine the efficiency of the columns.

Carbon columns and/or their contents are replaced as necessary, based on sample results and carbon column operating life. Dewatering is performed, in Segment 5, to enable the spent carbon to be disposed of in the Solid Waste Management Facility. The removal of mercury and heavy metals prior to the carbon columns precludes the spent carbon from being classified as a mixed waste (hazardous and radioactive). Typically, one cartridge filter downstream of the carbon columns is on line at a time to remove residual carbon fines, and the other is on standby. The filters remove 99% of the particles that are over 5 microns in size. The OR System effluent continues on to the RO System.

Loss of the OR System will result in a shutdown of the effluent treatment process, due to an inability to remove organic contaminants in the wastewater prior to the RO System. Any heavy metals present in the water could still be processed and removed further downstream by the Ion Exchange System (Section 1.1.6.4) mercury removal columns. However, this could result in more frequent cleaning or replacement of the RO membranes.

1.1.5.4 Cold Chemical Systems

The Cold Chemical Systems include:

- Nitric acid/caustic truck unloading station
- 10,000 gallon nitric acid and caustic storage tanks
- 13,000 gallon agitated nitric acid day tank (Physically located in Segment 6)
- 3,500 gallon agitated caustic day tank (Physically located in Segment 6)
- 4,500 gallon agitated sodium nitrate mix tank with cooler (Physically located in Segment 6)
- AN/FN truck unloading station
- 10,000 gallon AN and FN storage tanks

All chemical storage tanks are located within a diked area with a sump. The nitric acid/caustic truck unloading station has separate pumps to unload up to 45 weight % nitric acid and 50 weight % caustic into the storage tanks. The nitric acid and caustic are diluted with process water to 2-10 weight % in the caustic day tank and less than 25 weight % in the nitric acid day tank (both physically located in Segment 6) to meet process requirements. The AN/FN truck unloading station has separate pumps to unload up to 60 weight % AN and 45 weight % FN into the storage tanks. Ferric Nitrate is not currently used, and the FN system is abandoned in place.

Loss of the Cold Chemical System will result in a shutdown of effluent treatment process, due to an inability to:

- adjust pH levels of the wastewater at various processing stages;
- chemically clean components in the Filtration and Reverse Osmosis Systems (Sections 1.1.6.2 and 1.1.6.3); and
- regenerate the ion exchange cation columns (Section 1.1.6.4).

1.1.6 SEGMENT 6: TREATMENT BUILDING, CONTROL BUILDING, OTHER OUTSIDE TANKS, AND HEPAS

Segment 6 includes the Treatment Building, which contains the process equipment for submicron filtration, RO, ion exchange, and evaporation. Two mercury removal columns and the cation columns are located within the Treatment Building. This segment also contains the Control Building, the nitric acid/caustic day tanks, sodium nitrate tank, OR feed tank/feed pumps, treated water tanks, and HEPA filters. The air compressors are located in a storage area within the treatment building, separated from the process areas by firewalls. Note that the pH adjustment and feed tanks for the organic removal, and ion exchange processes, as well as the evaporator condensate hold tank and feed tanks (described below), are physically located outside the treatment building inside a diked area with a sump to provide containment for spills or tank breach. The sumps are pumped to the WWCTs or to the evaporator feed tanks for treatment.

1.1.6.1 pH Adjustment

Prior to filtration, the pH of the influent wastewater is adjusted to a range of 6-9 using less than 25 weight % nitric acid and 2-10 weight % caustic in order to cause the flocculant and other dissolved solids to precipitate out of solution and become suspended solids. The pH adjustment system consists of two agitated tanks in series (one 1,500 gallon and one 2,500 gallon) with gravity flow from each tank. The first tank does a coarse adjustment to a pH of 3-11 and the second tank adjusts the wastewater to the required range of 6-9.

1.1.6.2 Filtration

Filtration is the first unit operation performed on the wastewater at ETF (see Figure 1.1-2). The purpose of the ETF Filtration System is to remove suspended solids (mainly iron and aluminum hydroxides) from the wastewater prior to organic removal and RO to prevent fouling of the RO membranes. The Filtration System consists of a 2,500 gallon filter feed tank, three parallel filter trains, a 250 gallon filter concentrate tank, and a 300 gallon filter cleaning tank. The filter feed tank serves as a reservoir to provide sufficient Net Positive Suction Head for the filter train process pumps.

The three filter trains are ceramic crossflow filters that separate flow into permeate and concentrate streams. Each train has three stages, and each stage consists of a pump and four parallel filter housings. Ceramic filters remove suspended solids and concentrate them to approximately 1 weight %. Liquid backpulsing is utilized to periodically reverse flow through the filters to prevent a buildup of solids on the surface of the filter. The concentrate flow is directed to a 250 gallon filter concentrate tank, where it is kept recirculating to prevent solids from setting and salting. When the tank level reaches approximately 75%, the concentrate is pumped to the Evaporation System for volume reduction and concentration. Filtrate is sent to the OR System (Section 1.1.5.3).

Filter trains are regularly cleaned using premixed solutions of caustic, hypochlorite (bleach), nitric acid, or oxalic acid. The chemical cleaning solutions are circulated from a filter cleaning tank located adjacent to the filter feed tank through the selected filter train. The cleaning solutions are directed to the Evaporation System (Section 1.1.6.5) for disposal.

Loss of the Filtration System will result in an inability to remove suspended particles from the waste stream. This may result in a premature failure of the organic removal columns due to clogging and failure of the Reverse Osmosis System due to metal precipitation on the membranes. A shutdown of the effluent treatment process will result, due to an inability to treat wastewater and meet environmental discharge criteria.

1.1.6.3 Reverse Osmosis System

After being processed through the Filtration System and the OR System, the wastewater is processed in the RO System (see Figure 1.1-2). The RO System removes any dissolved solids (mainly sodium nitrate salts) and radionuclides from the wastewater. This section includes the following:

- RO feed cooler
- Three evaporative fluid coolers
- A 3,000 gallon agitated pH adjustment tank
- A 5,000 gallon feed tank
- Three feed pumps
- Three 100 gpm RO trains
- A RO cleaning circulation tank

The RO feed cooler reduces influent temperatures to prevent permanent damage to the RO membranes. In order to minimize scaling in the RO membranes, the pH of the feed is adjusted to approximately 6.0 using less than 25 weight % nitric acid. The RO feed tank serves as a reservoir for the RO trains and provides sufficient NPSH for the feed transfer pumps. RO feed pumps maintain the feed pressure at 500-800 psig as it enters the RO trains. Each of the three RO trains has four RO modules connected to form three stages (stage 1 contains two parallel modules and stages 2 and 3 each contain one module). Each module contains six 40 inch long by 8 inch diameter spiral wound semi-permeable membranes. The permeate is discharged to the Ion Exchange System, and the concentrate is sent to the evaporator feed tanks.

Loss of the RO System will result in a shutdown of the effluent treatment process due to an inability to treat wastewater and meet environmental discharge criteria.

1.1.6.4 Ion Exchange System

The IX System is the final chemical unit operation in the treatment process. Most of the cesium, strontium, and heavy metals that may still be present in the treated wastewater are removed here.

The primary equipment includes a 3,200 gallon agitated pH adjustment tank, a 5,400 gallon feed tank, two transfer pumps, two mercury removal columns, three cation columns, and two cartridge filters. A 2,700 gallon spent resin tank is also included for IX column resin changeout.

The IX influent is pH adjusted to 7-8, using 2-10 weight % caustic, to meet environmental discharge requirements. The water is fed from the feed tank to the mercury removal columns. The mercury removal columns operate in a parallel configuration and are filled with ion exchange resin that adsorbs residual mercury. The water then flows to the cation columns, which contain ion exchange resin that removes cesium and strontium. The water leaving the IX columns, flows to a cartridge filter, that removes residual resin, which may be present upon leaving the cation columns

Circulating a sodium nitrate solution through the columns regenerates the resin in the cation columns. Spent resin from the mercury removal and cation columns is stored in a spent resin tank prior to final disposal in the SWMF.

Loss of the IX System will result in a shutdown of the effluent treatment process due to an inability to treat wastewater to meet environmental discharge criteria.

1.1.6.5 Evaporation System

Evaporation reduces the liquid volume of the low-level radioactive waste received from the filtration and RO concentrate streams, as well as spent ion exchange regenerate and cleaning solutions used to flush various systems. This system includes two 24,000 gallon agitated feed tanks, two 4500 gpm forced circulation (recirculation pump) evaporators with two 50 gpm feed pumps, an air cooled condenser with two fans, a process condensate tank with two pumps, and two waste concentrate tanks with two transfer pumps. The evaporation process reduces influents to approximately 30 weight % concentrate. One feed tank is used to supply feed to the evaporator, while the other is in a feed receipt mode. The feed is pH adjusted to 5.0-7.0 using 2-10 weight % caustic or less than 25 weight % nitric acid prior to being fed to the evaporator. The water is heated with 40 psig steam to cause some of it to flash to vapors. The overheads (vapors) are directed to the entrainment separator and demister, which remove entrained liquid. The vapor is then condensed. Condensed evaporator overheads are collected in a process condensate hold tank prior to being transferred to the OR feed tank or WWCT for further treatment. The evaporator bottoms stream is transferred to the 1850 gallon waste concentrate tanks. The waste concentrate tanks are adjusted with 50 weight % caustic before being transferred to Tank 50 for storage prior to final disposal in Z-Area Saltstone or directly to Saltstone via the Tank 50 valve box, or to the H-Area Tank Farm via HDB-8.

Loss of the ETF Evaporator System would not affect the treatment process until the evaporator feed tanks become filled. Once the feed tanks are full, the wastewater treatment process will have to be shut down.

1.1.6.6 Control Building

The control building (241-84H) also includes a motor control center, maintenance shop, a chemical laboratory, a radiological control laboratory, and personnel change rooms. Transformers, a standby diesel generator, air compressor, cooling towers, and a 30,000 gallon process water tank with three 100 gpm pumps are located adjacent to this building. Electricity is supplied to ETF by two 13.8 kVA lines, which are stepped down via a transformer to 480 VAC. A diesel generator (254-9H) provides adequate standby power to the DCS and essential loads. The entire ETF process is monitored and controlled by a redundant DCS. In the event of a loss of power, an online uninterruptable power supply is designed to ensure a continuous power supply to the DCS until the diesel generator is on line. The entire process is designed to automatically go into a "fail safe" shutdown condition upon loss of power.

1.1.6.7 Heating, Ventilation, and Air Conditioning

The Heating, Ventilation, and Air conditioning system includes one air supply unit for the Treatment Building, two air supply units for the Control Building, the vessel vent system, the building exhaust system including "shrouded probe" samplers, and the exhaust stacks. The vessel vent system draws air from each potentially contaminated vessel through one of two smaller HEPA filters prior to being tied to the building ventilation system.

The control building ventilation system routinely uses one of two blowers to draw air from the laboratories (lab hoods), maintenance shop, and change rooms through two large HEPA filter banks prior to atmospheric release via the small stack.

Loss of the HVAC System could result in:

- erratic operation of the sensitive DCS equipment due to loss of temperature and humidity control or buildup of static electricity;
- uncomfortable operating environments for personnel; and
- buildup of airborne contamination and/or toxic gases in the process tanks.

1.1.6.8 Treated Water System

The ETF Treated Water System is the final stage of the effluent treatment process. This system consists of two samplers, three storage tanks, two transfer pumps, and one recycle pump. Water leaving the IX System is sampled via a continuous, proportional type sampler and collected in one of the three Treated Water Tanks until samples are analyzed to verify that discharge requirements are met. Once a batch of water is confirmed to meet NPDES specifications (with the exception of BOD which is confirmed after the release), it is discharged to UTRC via a regulated outfall. If the treated water does not meet the NPDES discharge criteria, it is recycled to the WWCTs for retreatment through the entire process to remove remaining contaminants. An additional sampler is located near the outfall at UTRC, to draw a series of samples from the treated water as it is discharged to the creek.

Loss of the Treated Water System will result in a shutdown of effluent treatment process or total diversion of the water from the IX process to the WWCTs (after Treated Water Tanks are filled), due to an inability to sample the treated water to determine if the environmental discharge requirements are satisfied.

1.1.7 SEGMENT 7: WASTE STORAGE AREA

The Waste Storage Area is a concrete pad and the adjacent gravel area located north of and across the paved road from the OR Carbon Columns (Segment 5) and east of the Treatment Building (Segment 6). Spent Carbon Columns and waste packages containing spent ion exchange resins or carbon from Segments 5 and 6, basin sediments and spent resins from the basin deionizers, along with any radiologically contaminated soils associated with facility operations are stored here prior to shipment for disposal.

Routine Job Control Wastes (drums, B-12s, and B-25s) may be stored in this area prior to shipment, but are not included in the segment inventory due to their minimal contribution. Individual packages of Job Control Waste constitute less than 0.001% of the Hazard Category 3 threshold, contain less than 5 millicuries total activity, and have maximum doserates slightly above background.

Loss of the Waste Storage Area would not affect the treatment process.

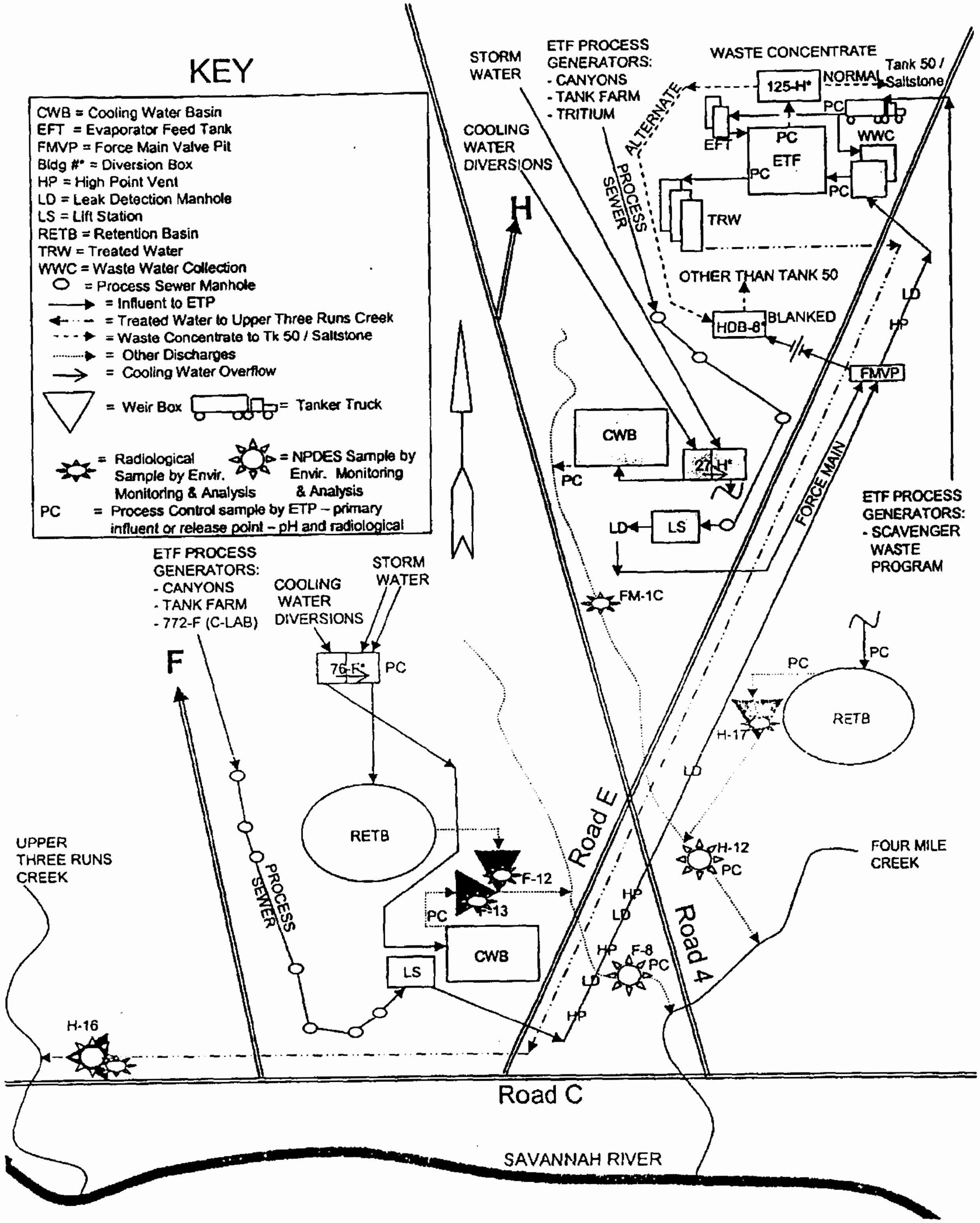

Figure 1.1-1. Location / Process Flows of the ETP at the Savannah River Site

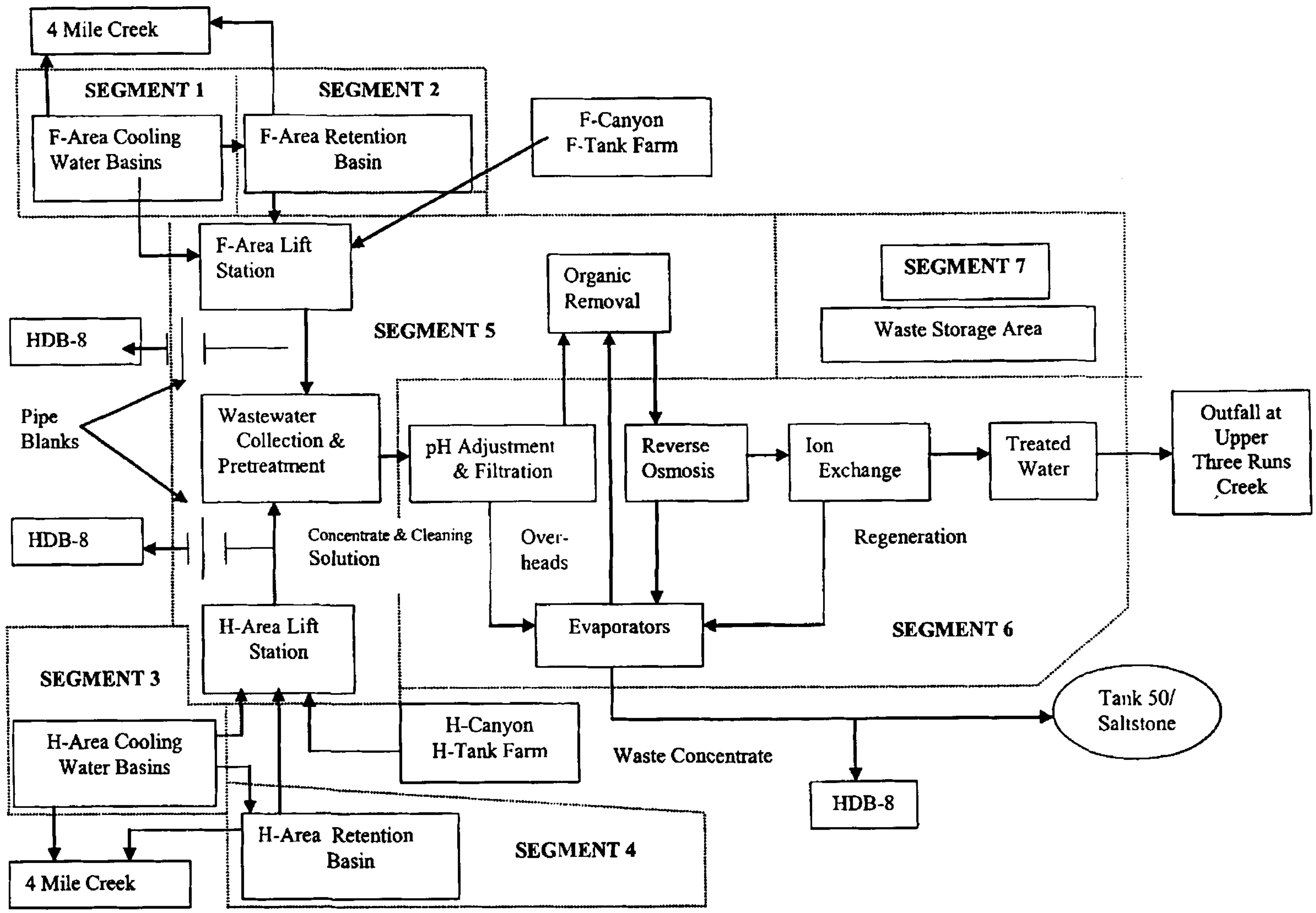

Figure 1.1-2 ETP Process Flowpath and Segmentation

ETF PLOT PLAN

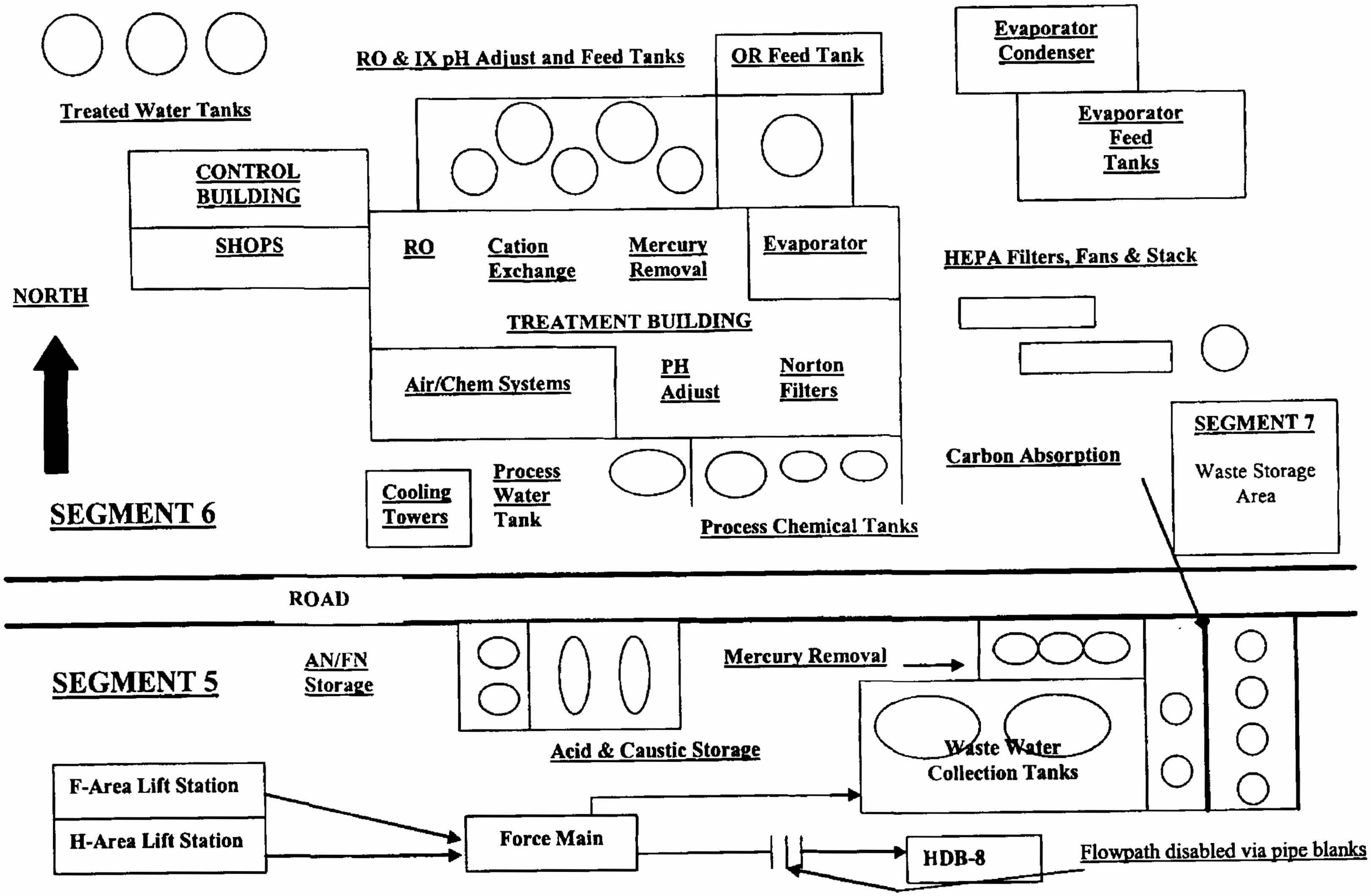

Figure 1.1-3 ETP Process Plot Plan and Segmentation

2.0 INPUT DATA & KEY ASSUMPTIONS

2.1 The concentrations of radionuclides in the WWCTs are assumed to be at 25% of the maximum permitted by the ETP Waste Acceptance Criteria [11]. The WAC is based on historical performance and knowledge and analysis of the upstream waste processes along with process knowledge of the ETP's capability to remove contaminants [43]. All deviations from the WAC shall be evaluated by ETP Engineering and approved by the ETP Project Manager.

2.2 Downgrading the ETF to a "Radiological Facility" has had little or no effect on the major existing waste generators. However, future waste streams may be affected. Multipliers have been identified as input data for the beta-gamma and alpha basin limits, to demonstrate the margin between the WAC and the Category 3 Threshold Limits specified in DOE-STD-1027-92 [3]. The inventory calculations [12, 13] were based on a larger concentration of non-tritium radionuclides than are currently allowed by the WAC.

2.3 All basins, tanks, vessels, and piping are assumed to be full of liquid at the WAC limit [11], with the following exceptions.

2.3.1 The liquid activity of all components contained in Segments 1 through 4 is assumed to be 3 d/m/ml Alpha and 16 d/m/ml Beta-gamma (discharge limit for basins) and 2500 d/m/ml tritium (20x highest recorded value from Environmental Monitoring Computer Automation Program Information Delivery System Release Reports).

2.3.2 The liquid activity of all components in Segment 5 assumes 100% of the WAC limit for the Lift Stations and Force Main (100 d/m/ml Alpha and 2500 d/m/ml Beta-gamma), and 25% of the WAC limit (based on historical data of WWCT and Lift Station sample analyses) for all other components (25 d/m/ml Alpha and 625 d/m/ml Beta-gamma).

2.3.3 In Segment 6, the liquid activity is assumed to be at 25% of the WAC limits (25 d/m/ml Alpha and 625 d/m/ml Beta-gamma), and is further modified in the following groups of components for the stated reason:

1) Reverse Osmosis (RO) housings, Evaporator Feed Tanks (EFT) and EFT piping are assumed to be 10 times the 25% WAC limits (2.5 x WAC) due to RO concentration (250 d/m/ml Alpha and 6250 d/m/ml Beta-gamma),

2) Evaporators, Waste Concentrate Tanks (WCT), and WCT piping are assumed to be at 175 times the 25% WAC limits (43.75 x WAC) due to concentration (4375 d/m/ml Alpha and 109375 d/m/ml Beta-gamma),

3) Ion Exchange (IX) Columns, Evaporator Condensate Hold Tank, Treated Water Tanks (TWT), and TWT piping are assumed to be at 0.01 times the 25% WAC limits (0.0025 x WAC) due to decontamination (2.5E-01 d/m/ml Alpha and 6.25 d/m/ml Beta-gamma).

2.3.4 If the assumed Alpha and/or Beta-Gamma value(s) (25% of WAC limit) in the WWCTs are exceeded, an engineering evaluation is required prior to processing.

2.3.5 *The initial liquid activities assume zero* I^{129}. *Historical evidence indicates* I^{129} levels well below minimum detectable until concentrated by activated charcoal or resin (Attachment 1, reference 1).

2.3.6 Tritium is assumed to remain at 250,000 d/m/ml throughout Segments 5 and 6. If 250,000 d/m/ml is exceeded, an engineering evaluation is required prior to processing.

2.4 Attachment 1 contains inventory control guidelines for determining additional inventories due to hold-up in individual segments.

2.5 Process columns which are physically disconnected and no longer in service and the associated waste are removed from the process segments and staged in a separate segment (Segment 7) while awaiting shipment to the SWMF for disposal. Columns and resins stored in this area will be sampled to ensure that the total inventory of the segment does not meet or exceed the Hazard Category 3 Threshold Limits, as defined in DOE-STD-1027-92 [3]. Job control wastes, as discussed in 1.1.7, are not included in the Inventory Control Program.

2.6 Segmentation as described in Section 1.1 of this ASA is required to ensure that the facility is maintained as a "Radiological Facility" (e.g., the radiological inventory for each segment is less than the Category 3 Threshold Limits specified in DOE-STD-1027-92 [3]).

2.7 The preventative and mitigative features identified in Section 4.0 of this ASA are not required for maintaining the facility within the Facility Hazard Category in the postulated events as described [36]. These features are identified only to provide an additional layer of protection for the offsite public, on-site worker, and the environment.

2.8 The radioactive sources and standards contained within the facility (located in Segments 1 through 6) constitute less than 0.02% of the Hazard Category 3 threshold and therefore are not included in the inventory control program [40]. Sources are controlled by 5Q1.1, 502, "Radioactive Source Accountability and Control" [41].

2.9 The ETP influent sources contain a broad spectrum of radioisotopes. These sources are analyzed for alpha and beta / incidental gamma, reported as total alpha and total non-volatile beta-gamma. This is not a "true" total beta-gamma analysis, but in the absence of pure gamma emitters (such as Cr^{51}), it is sufficient for the inventory control program. All gamma emitters at ETP are also alpha or beta emitters and are captured in these analyses.

2.10 Based on historical data and process knowledge the evaporator overheads, returned to Segment 5, contain minimal activity, and are ignored for the purposes of inventory control.

2.11 The beta-gamma radionuclide distribution assumes $Sr^{90}/ Cs^{137} \leq 1$. This distribution is based on influent sources and analysis of ETP resin and carbon media.

3.0 DESIGN AND OPERATIONAL SAFETY CONTROLS (PRINCIPAL CONTROLS)

3.1 IDENTIFICATION OF PRINCIPAL CONTROLS

This section of the ASA identifies the principal controls necessary to ensure the preservation of the Facility Hazard Category; thereby, ensuring the protection of ETP employees, the public, and the environment. Any proposed activity or discovery which could impact the principal controls shall be evaluated using the Management of Safety Basis (MSB) process, as outlined in WSRC Manual 11Q [2], Procedure 1.07, or other Division approved process. The results of this evaluation shall be documented.

The principal design and operational safety controls for the ETP are:

(1) Provide/maintain facility segmentation as described in Section 1.1 of this ASA

- All inter-segment transfers (Basins to ETF and wastewater processing) shall be administratively controlled in accordance with approved procedures to ensure the tracking of inventory across segments.

- Process columns which are physically disconnected and no longer in service and the associated waste will be sampled and removed from the process segments and staged in a separate segment (Segment 7) while awaiting shipment to the SWMF for disposal.

(2) Maintain an Inventory Control Program to ensure that the maximum radiological inventory in a Facility Segment is less than the Hazard Category 3 threshold limits specified in DOE-STD-1027-92 [3].

<u>Segments 1-4</u>

- ETP shall collect a grab sample of any accumulated solids in segments 1-4 annually, if sufficient sample volume is available.

- ETP shall conduct at least one evaluation per year of the total radionuclide inventory of segments 1-4.

<u>Segments 5, 6 and 7</u>

- Inventory Control procedures shall be developed and maintained by the facility to ensure that the total inventory of each segment does not meet or exceed the Hazard Category 3 Threshold Limits, as defined in DOE-STD-1027-92 [3].

- ETP shall evaluate the total radionuclide inventory at least once per month.

- Sampling of spent media shall be performed after change out of a process column or its contents to re-establish the baseline radionuclide inventory of the segment.

- An internal inspection shall be performed on the process tanks in segments 5 and 6 at least once every 10 years, to determine if there is an accumulation of activity bearing solids. If significant accumulation is observed during any internal inspection, samples will be taken and analyzed and used with an engineering estimate of volume to determine holdup activity. Note that historically, Segment 5 vessels require inspection and sampling much more frequently, as driven by holdup calculations within the inventory control procedures.

  Internal inspections will be performed on the following:

  Lift Station Tanks (2)

  Waste Water Collection Tanks (2)

  OR Cleaning Tank, OR De-watering Tank, and OR Feed Tank

  pH Adjustment Tanks (2)

  Filter Concentrate Tank and Filter Feed Tank

  Waste Concentrate Tanks (2)

  Evaporator vapor bodies (2)

  Spent Resin Storage Tank

  RO Cleaning Tank, RO Feed Tank, and RO pH Adjustment Tank

  Evaporator Feed Tanks (2)

  Process Condensate Hold Tank

  IX Feed Tank, and IX pH Adjustment Tank

  Note: The NaNO3 Recycle Tank is abandoned in place and isolated from the process. Hence, it does not have to be inspected.

  The Filter Cleaning Tank is used to heat chemical cleaning solution and is flushed several times per batch, and as such internal inspection is not deemed necessary. The Treated Water Tanks do not require inspection based on the minimal suspended solids, low conductivity, and less than detectable Beta-Gamma concentrations of the process effluent.

  The OR Carbon Columns (3), OR Mercury Removal Columns (3), IX Cation Columns (3) and IX Mercury Removal Columns (2) contents are removed and replaced or regenerated more frequently than once every ten years. Media removed from these vessels will be sampled to determine physical holdup of material. If the media is not replaced or regenerated within ten years, visual inspection and/or sampling will be used to determine holdup.

- A volumetric check or visual inspection of the Waste Concentrate Tanks shall be performed annually, to determine if there is an accumulation of activity bearing solids.

(3) The maximum allowable concentration of nitric acid stored in the facility shall not exceed 45 weight % [14].

(4) All new process chemicals (chemicals used in the process or laboratory) shall be evaluated prior to initial acceptance into the facility inventory to ensure that the gross chemical inventory does not exceed the Threshold Quantities of 29 CFR 1910.119 [15] and 40 CFR 68 [16]. If a chemical does not have a TQ, the Threshold Planning Quantity of 40 CFR 355 [17] shall apply.

(5) The ETP shall only accept waste streams that meet the requirements of the ETP Waste Acceptance Criteria or have approved WAC deviations.

- All deviations from the WAC shall be evaluated by ETP Engineering and approved by the Project Manager.

- ETP Engineering shall evaluate the potential impact on radionuclide inventory whenever treatment of a new or revised wastewater stream is considered.

(6) An annual verification of the assumed radiological distribution used in the Inventory Control Program shall be performed and revisions of the Inventory Control Program, procedures and supporting calculations shall be issued if assumptions are exceeded, i.e. Sr-90/Cs-137 > 1.

3.2 BASIS FOR PRINCIPAL CONTROLS

3.2.1 FACILITY SEGMENTATION

3.2.1.1 Facility Segments 1-4

Segments 1, 2, 3, and 4 are physically separated by distance such that the segmentation described by Section 1.1 of this ASA is maintained (Figure 1.1-1). Piping interconnections exist between Segments 1-2 and Segments 3-4 as well as between each of these four segments and Segment 5. However, the interconnecting piping handles only noncombustible liquids and cannot propagate a fire or explosion from one segment to the other. Further, the design of the interconnecting piping system precludes the simultaneous release of the hazardous material in both segments should a breach of the interconnecting piping occur. In addition, design features such as the lining in the cooling water/ retention basins and administratively defined "fill levels" for the basins prevent water seepage beyond the segment boundaries. The basin surveillance operator monitors basin levels at least once per day. If either basin reaches the "fill level", procedures are implemented to minimize influent in order to prevent basin overflow. During normal operations, the basins should never be filled above the "fill level". The ASA takes no credit for normal operation and assumes basins are full to overflow volumes. If the total volume of the diversion exceeds the capacity of Segments 1 or 3, the excess cooling water will be routed to the retention basins (Segment 1 to Segment 2 and Segment 3 to Segment 4 respectively). Administrative controls have also been procedurally implemented to:

- Transfer wastewater from/within the basins to ETF, H-Tank Farm, or Four Mile Creek
- Collect and discharge stormwater at the basins
- Manage stormwater during basin outages

3.2.1.2 Facility Segments 5, 6 and 7

A paved road (Figure 1.1-3) physically separates segments 5 and 6. The separation distance between these segments is judged sufficient to preclude a hazardous event in one segment from causing the release of hazardous material in the other segment. Piping, designed to nationally recognized codes and standards, provides the only connection between segments 5 and 6. This piping handles only noncombustible liquids and cannot propagate a fire or explosion from one segment to the other. Further, the design of the interconnecting piping system precludes the simultaneous release of the hazardous material in both segments should a breach of the interconnecting piping occur. A flowmeter is installed in the transfer pump discharge piping to monitor the total wastewater flow to the Treatment Building (Segment 6). A building area floor sump is located within the treatment building to collect and contain spills or leaks from equipment/ piping located within the building. A sump pump is provided to automatically drain the building sump via the evaporator floor sump (#1) to one of the evaporator feed tanks or to the WWCTs. A building sump alarm is provided to alert the CRO. A sump header is installed along the outside of the Treatment Building to route fluids back to the WWCTs. All segment 5 to segment 6 transfers shall be administratively controlled in accordance with approved procedures to ensure segment inventory limits are not exceeded. Integrated Operating Procedure Manual SW22.2-IOP-1 [18] is the primary procedure which defines the restrictions/conditions for transfers between segments. However, other approved operating procedures and special procedures are utilized as well. Segment 7 is physically separated from Segments 5 and 6 by a distance judged sufficient to preclude a hazardous event occurring in Segment 5 or 6 that causes release of Segment 5 or 6 hazardous material from also causing release of Segment 7 hazardous material inventory. There is no connection between Segment 7 and any other segments. When items are physically removed from Segments 5 and 6, and moved to Segment 7 for storage, their inventory is subtracted from Segment 5 or 6 and added to Segment 7.

3.2.1.3 Worst Case Radiological Release

3.2.1.3.1 Scenario Development and Assumptions

As documented in Reference 12, Segments 5 and 6 have the largest radiological inventory associated with the operation of the ETP. Segments 5 and 6 are physically separated. A road, passive facility features such as sumps, and topography features preclude Segment 5 and 6 inventories from interacting under static accident conditions. However, when operating, inventory is pumped from the WWCT in Segment 5 to the filter feed tank in Segment 6 and then back to Segment 5 (OR feed tank to OR process columns), and then back to Segment 6. Essentially, Segments 5 and 6 communicate when the facility is operating. Since Segments 5 and 6 contain the largest radioactive inventories and potentially could interact, this situation was examined by an engineering team (ETP Engineering and Solid Waste Safety Compliance) to determine the largest, credible radiological inventory, which could physically be released from the facility.

As previously noted, Segments 5 and 6 are physically separated and passive facility features as well as terrain features preclude interaction under static conditions. Additionally, process upsets, spills, explosions and fires in one segment will not affect (cause a release) or propagate to the adjacent segment. Physical separation and the waste medium (water) preclude this type interaction. However, Natural Phenomena Hazards (NPH) events such as seismic or wind have the potential to cause multiple releases simultaneously. The engineering team postulated that a seismic or wind event that caused extensive damage to the treatment building in Segment 6 while processing waste water from the WWCT in Segment 5 has the potential to release the largest radioactive inventory. The scenario is as follows:

- Segment 6 is at or near its maximum radiological inventory.
- The on-line WWCT is full and a transfer has just been initiated. The offline WWCT is not lined up to provide material to Segment 6 and as described, facility and terrain features preclude spilled material in Segment 5 from interacting with Segment 6.

- A seismic or wind event occurs and results in extensive damage to the treatment building. Multiple tanks and lines are breached in Segment 6. The entire radioactive inventory in Segment 6 is assumed to be released.

- The online WWCT is not damaged in the event nor is the piping out of Segment 5 (conservative assumption as allows transfer to continue to Segment 6). Power remains available to the transfer pump and the contents of the WWCT are pumped through a broken line in or near the treatment building in Segment 6.

- The WWCT liquid activity is at 25% of the WAC limit. This is consistent with Assumption 2.3.2 in the Inputs and Assumptions Section of this document and representative of historical sample analysis. Deviation from this requirement requires an engineering evaluation prior to implementation (See Assumption 2.3.4).

- No credit is given for operator intervention. Existing administrative controls and procedures for emergency response would require facility shutdown (e.g., stop the transfer from the WWCT). However, this requirement is conservatively ignored.

    - It is recognized that the unmitigated frequency of occurrence for this event is "Unlikely" and combined with operator intervention is likely incredible. However, this event certainly represents the "worst case radiological release" possible from the facility.

3.2.1.3.2 Release Inventory

The maximum radioactive inventory that can be released from the facility as defined in the preceding event was compared against the Hazard Category 3 Threshold Quantities (TQ) as defined in DOE-STD-1027-92 [3]. Reference 43 calculated that the maximum available sum of the ratios of the liquid radioactive inventory in a single WWCT to the DOE-STD-1027 –92 Hazard Category 3 TQs limits. The WWCT sum of ratios is 7.29E-02 (based on 25% of the WAC limit). Likewise, Reference 12 determined that the maximum potential sum of the ratios of the inventory in Segment 6 to the Hazard Category 3 TQs is 0.81. This value includes multipliers, at higher than typical facility operating conditions, to ensure that the Hazard Category 3 limits are not exceeded. The actual liquid and holdup sum of the ratios for Segment 6 is 0.26 as calculated in Reference 43. Therefore, the maximum potential sum of the ratios of the released inventory to the limits following this postulated "Worst Case Radiological Release" would be 0.883, which is less than the 1.0 as required by DOE-STD-1027-92 [3].

$$0.073 + 0.81 = 0.883$$

Even with the incorporation of conservative multipliers, the treatment building (Segment 6) could receive the entire inventory of the online WWCT and not exceed the Hazard Category 3 threshold limits. Therefore, the Segment 5 and 6 boundaries are effective in precluding the release of more than a Hazard Category 3 Threshold Quantity and no additional controls are required as a result of the worst case radioactive release.

3.2.2 RADIOLOGICAL INVENTORY CONTROL

3.2.2.1 Inventory in Retention/Cooling Water Basins (Segments 1-4)

Solids will accumulate in segments 1-4. The solids may contain a concentration of radionuclides greater than the basin water. Reference 1 has already accounted for a basin inventory higher than the WAC in downgrading the Hazard Baseline for the ETF to a "Radiological Facility". The following actions shall be taken to control the radionuclide inventory in Segments 1-4:

1. ETP shall collect a grab sample of any accumulated solids in segments 1-4 annually, if sufficient sample volume is available. Samples shall be analyzed for alpha, beta-gamma, and I-129, resultant sludge activity calculated, and accounted for in the segment inventory.
2. ETP Engineering shall conduct at least one evaluation per year of the total radionuclide inventory of segments 1-4 to ensure that the total inventory of the segment remains less than the Hazard Category 3 Threshold Limits. The yearly frequency is justified by Reference 13.
3. An inventory of waste and portable de-ionizers, if applicable, stored in the segment will be maintained and its contribution accounted for in the segment in which it is stored.

3.2.2.2 Inventory and Methodology for Determining Increases in Inventory (Segments 5, 6 and 7)

Facility approved inventory control procedures shall be developed and maintained to ensure that the total inventory of each segment does not meet or exceed the Hazard Category 3 Threshold Limits, as defined in DOE-STD-1027-92 [3]. These procedures should include a method for determining the maximum radionuclide inventory for each segment, and the level of increase in the radionuclide inventory due to accumulation within ETP process tanks and piping. Uncertainty as a result of errors in tank level indication (including adjustments for specific gravity of the waste concentrate streams) has been incorporated into the inventory calculations. The accuracy of the level instrumentation and the calibration thereof on the Waste Water Collection Tanks and Evaporator Feed Tanks is $\pm$ 3%. Due to the $\pm$ 3% accuracy, reported influent volumes will be increased 3%. The effluent volumes from the Waste Concentrate Tanks is determined from a totalizer in the discharge line with an accuracy of $\pm$ 1%. Due to the $\pm$ 1% accuracy, reported effluent volumes will be decreased 1 %. Guidelines for developing the inventory control procedures are contained in Attachment 1. These guidelines are based on methodology as contained in Reference 19. ETP Engineering shall evaluate the total radionuclide inventory at least once per month.

An evaluation shall also be conducted prior to initial acceptance of any waste stream added directly to the process downstream of the WWCTs to ensure that the total inventory of each segment does not meet or exceed the Hazard Category 3 Threshold Limits, as defined in DOE-STD-1027-92 [3]. The decision to changeout or clean the columns may be made based on the results of this evaluation. The anticipated frequency of changing or cleaning the process columns is every 2-3 years based on inventory hold up in the process columns and on equipment operating life. Sampling shall be performed after changing or cleaning out a process column to re-establish the baseline radionuclide inventory of the segment.

An internal inspection shall be performed on the process tanks in segments 5 and 6 at least once every 10 years. A volumetric check or visual inspection of the Waste Concentrate Tanks shall be performed annually. The tank inspection schedule may be accelerated, as required, based on the monthly inventory evaluation. The physical inventory of Segment 7 will be verified against the monthly inventory as reported in the appropriate Inventory control Procedure.

An annual verification of the assumed radiological distribution used in the Inventory Control Program shall be performed to validate continued use of this assumption in supporting calculations and procedures.

3.2.2.3 Fissile Material Inventory Control

Fissile material will not be present in sufficient quantities to make criticality a credible event (see References 20 and 21). These references demonstrate that there is no credible mechanism and no favorable locations for accumulation of fissile material in the ETP systems. The ETP currently does not require a Fissile Material Inventory Control Program. The ETP Hazard Baseline Classification shall be re-evaluated at a future time if the facility will be required to accept substantially more fissile material due to new missions. A Fissile Material Inventory Control Program may be implemented at a future date.

Transition of Tank 50 to High Level Waste service occurred when the Tank 50 valve box was tied into H diversion box 7 (HDB-7). A Nuclear Criticality Safety Evaluation (NCSE) by WSMS determined that an inadvertent transfer from HDP to ETP could result in a criticality [46]. The NCSE identified four barriers that are in place to ensure a criticality in the ETP is incredible. Those barriers are:

1. A dedicated HDP Tank operator assigned to perform the transfer through the Tank 50 Valve Box is required to procedurally record level indication for both ETF Waste Concentrate Tanks prior to initiating the transfer through the Tank 50 Valve Box and at 20-minute intervals for the first 40 minutes. The operator should notice an abnormal increase in level in WCT during the first monitoring at 20 minutes but most conservatively notices the discrepancy within the first 40 minutes.

2. The HDP Shift Manager or First Line Manager will request ETP to provide an alternate pathway for Tank 50 Valve Box inadvertent transfer (e.g. open WEE-V-482 to HDB-8 Pump Tank 10) per the governing transfer procedure for Tank 50. Additionally, the HDP Shift Manager or First Line Manager will request HDP to provide an alternate pathway for Tank 50 Valve Box inadvertent transfers (e.g. open WTS-V-194 to HDB-8 Pump Tank 10) per the governing transfer procedure for Tank 50.

3. During non-ETF transfers, the ETF system will be isolated from the Tank 50 Valve Box by alignment of the system valves by the influent/effluent transfer procedure valve alignment checklist for Tank 50.

4. HDP Operations personnel will periodically (i.e. annually) test the check valve integrity and the transfer path to HDP with a leak test procedure. An ETP operating procedure verifies the integrity of the ETF check valves (WEE-V-242 and WEE-V-434). HDP Operations ensures this procedure is completed successfully.

3.2.3 CHEMICAL INVENTORY CONTROL

3.2.3.1 Nitric Acid

The maximum allowable concentration of nitric acid stored in the facility shall not exceed 45 weight % [14]. Based upon a detailed engineering evaluation [23], it has been determined that this concentration will not trigger any Emergency Action Levels given a spill of the entire 10,000 gallon maximum inventory of 45 weight % acid. The engineering evaluation concluded that at higher storage concentrations a spill would exceed the Emergency Response Planning Guide (ERPG-2) of 15 ppm for nitric acid. This could require the development of a facility specific Emergency Response Plan. Note that the requirement to limit the nitric acid storage concentration is strictly based on emergency preparedness considerations as opposed to safety. Even at the previous storage concentration of 64 weight %, nitric acid was classified as a common industrial hazard for which national consensus codes and standards exist to guide safe design and operation.

A simultaneous release of caustic and nitric acid could potentially produce heat due to the strong exothermic reaction. However, additional analysis is not required for the potential hazard beyond the release of nitric acid alone since precautions taken to address the nitric acid release will protect against the caustic/nitric acid release [39].

3.2.3.2 Other Hazardous Chemicals

Chemicals currently used/ encountered in the ETP are listed in Appendix A, Table A-1 along with their respective RQs, TPQs, and TQs. This table should be periodically revised so as to accurately reflect the nature and extent of the ETP chemical hazards. Any proposed new process chemical brought into the ETP will be screened to ensure that it meets one or more of the following criteria:

1. The material is commonly used by the general public. This includes any substance to the extent it is used for personal, family, or household purposes or is in the same form, concentration, and end user amounts as a product packaged for distribution and use by the general public.
2. The material is not hazardous to humans as a result of inhalation.

Based upon the screening, additional preventive or mitigative features may be required to minimize the hazards derived from the chemical.

3.2.4 COMPLIANCE WITH WAC

3.2.4.1 Waste Compliance Plan

Wastewater primarily enters the ETF process via the two process sewers with lift stations, which in turn feed the WWCTs. Other waste streams are introduced to the ETF via tank truck or portable vessels from waste generators such as F-Area and H-Area Canyon Outside facilities, F/H Tank Farms, or purge water from Environmental Restoration. The ETF may also receive wastewater from the ETP basins during certain evolutions. Each generator has a responsibility to develop, implement, and maintain an approved Waste Compliance Plan to ensure that waste transferred to the ETF can be safely processed. The Waste Acceptance Criteria [11] and the Waste Compliance Plan will provide the necessary control to ensure that waste transferred to the ETF can be safely processed. At a minimum, the generator developing the Waste Compliance Plan should address:

- A description of the waste generation process, including process flow (e.g., transfer volumes and frequencies)
- A description and inventory of chemicals and radionuclides used in the generation process which could affect the waste stream composition
- Waste stream characterizations
- A description of waste processing activities that ensure compliance with the WAC
- A description of waste minimization activities
- Justification for deviations from WAC requirements, if required.

As stated in Section 2.2 of this ASA, the WAC provides some flexibility for treating streams that may exceed the criteria as specified in Reference 11. Deviations to the WAC involving stream specifications should be approved by both the sending and receiving Divisions and documented in the Waste Compliance Plan and/or the WAC Deviation Form. ETP Engineering shall evaluate the potential impact on radionuclide inventory whenever treatment of a new or revised wastewater stream is considered. This evaluation shall be documented in an MSB. All deviations from the WAC shall be evaluated by ETP Engineering and approved by the ETP Project Manager.

3.2.4.2 Tank Farm WAC/ Saltstone WAC Requirements

The Liquid Waste Disposition Projects have developed a WAC to ensure safe, sound operation of the tank farms and downstream facilities [45]. For transfers of ETF waste concentrate to HDP via HDB-8, the program ensures that ETF transfers are properly characterized and managed to comply with this WAC. The compliance strategy is described in the Waste Compliance Plan for Liquid Transfers prepared and maintained by ETP Engineering and approved by H Disposition Project Operations and Engineering. Compliance with the Waste Compliance Plan ensures that waste streams transferred from ETF to HDP are within the Tank Farm WAC requirements and Authorization Basis.

Revisions to the WAC involving stream specifications shall be approved by both HDP and ETP Operations and Engineering and documented in the Waste Compliance Plan, including any approved deviations per the 1S Manual. These revisions should be reviewed against the LWDP Documented Safety Analysis (DSA) (by LWDP Engineering) using the USQ process.

ETF waste concentrate transfers to Tank 50 are also governed by the Tank Farm WAC and, by default, the Saltstone WAC [24] since all waste transferred into Tank 50 must be suitable for Saltstone as well. Transfers directly from ETF to Saltstone are governed solely by the Saltstone WAC. Any transfers that do not meet the WAC limits must have an approved deviation.

4.0 NON-PRINCIPAL PREVENTIVE AND MITIGATIVE FEATURES

The preventive and mitigative design features, administrative controls, and programs are cited in Reference 36. These features will provide additional assurance that the workers, the public, and the environment are protected from the anticipated hazards that could reasonably be expected to originate from the operation of the ETP. However, these controls are not required for maintaining the facility hazard category of the ETP. A risk assessment for each potential hazard was not required since the highest consequence for the ETP was determined to be a minor facility impact. Therefore, frequency and consequence evaluations were not considered in the hazard assessment tables [36].

4.1 SITE PROGRAMS

ETP will operate in compliance with the following existing Site Programs. Changes to these programs do not necessarily have to be evaluated by the ETP.

Program	Manual
Radiation Protection	WSRC Manual 5Q [25]
Fire Protection	WSRC Manual 2Q [26]
Industrial Safety	WSRC Manual 8Q [27]
Industrial Hygiene	WSRC Manual 4Q [28]
Conduct of Operations	WSRC Manual 2S [29]
Quality Assurance	WSRC Manual 1Q [30]
Training and Qualification	WSRC Manual 4B [37]
Safe Electrical Practices and Procedures	WSRC Manual 18Q [38]
Security Manual	WSRC Manual 7Q [44]
Conduct of Maintenance	WSRC Manual 1Y [31]

4.2 INDUSTRIAL HEALTH HAZARDS

Personnel performing work activities at the ETP may be subject to common industrial hazards. The preventive and mitigative features for these hazards fall entirely within the scope of the standard safety controls as contained in WSRC Manuals 2Q, 4Q, 8Q, and 18Q. Typical industrial hazards associated with the ETP's operations along with the preventive and mitigative features, which minimize these hazards, have been identified and are documented in Reference 32.

5.0 HAZARD ASSESSMENT

5.1 METHODOLOGY

This section presents an overview of the methodology used to identify and characterize hazards and to perform a systematic assessment of basic accidents.

5.1.1 HAZARD IDENTIFICATION AND ASSESSMENT

The purpose of the hazard identification and assessment is to present a comprehensive summary of potential process-related hazards, natural phenomena, and external hazards that can affect the public, workers, and the environment due to single or multiple failures. This assessment considers the potential for both equipment failure and human error.

The hazard assessment provides a thorough identification of potential events, event initiators, preventative and mitigative features, including identification of expected operator response to incidents (e.g., accident mitigation actions or evacuation) and provisions for operator protection in the accident environment. The preventative and mitigative features include both design features and administrative controls (procedures, policies, and programs). With the exception of the Inventory Control Program, these features are identified only to provide an additional layer of protection for the offsite public, on-site worker, and the environment. In general, the preventive and mitigative features are not credited for maintaining the facility within the FHC in the postulated events described [36].

The hazards associated with the ETP are radiological, chemical, and industrial in nature.

5.1.1.1 Hazard Identification

Hazards are primarily identified by listing energy sources and hazardous materials and identifying hazardous locations. Information for identifying hazards and determining their applicability to the facility is obtained, as applicable, from the following sources:

- Existing projects
- Safety and environmental documents
- Design drawings and reviews
- Facility walkdowns and equipment data
- Consultations with facility experts

Hazard identification was performed by a safety analyst and later confirmed by the Lead Engineer who is knowledgeable in the operation of the ETP. In order to perform the hazard assessment, quantities of specific radionuclides and hazardous chemicals were obtained from Reference 1.

The hazards identified in this facility are based on the radioactivity levels associated with the waste, the chemical toxicity of the waste, and any other energy sources that may be present in the facility.

This hazard identification process provides the information required to perform both radiological and chemical hazard assessments. In addition, this process identifies industrial hazards and routinely accepted hazards but these are not included in this safety analysis. Standard industrial hazards and routinely accepted hazards are identified only to the degree that they are initiators and contributors to events resulting in radiological and chemical hazards. The following characteristics are used to determine that hazards are standard industrial hazards and routinely accepted hazards:

- The hazard is routinely encountered first-hand by the general public in the home, home workshop, or in public areas.
- No evidence exists that there are public or employee concerns about the hazard beyond normal prudence.
- The hazard is subject to Occupational Safety and Health Administration regulations.

Protection against industrial hazards and routinely accepted hazards is basic safety in the workplace. These hazards are formally and systematically treated by the programmatic elements listed as follows:

- Procedure Manual 8Q, Employee Safety Manual [27] defines basic site-wide safety policies and minimum requirements. This procedure manual is augmented by detailed rules and procedures developed by departments and facilities for activities within their areas of responsibility, and requires compliance with DOE Orders and OSHA regulations at a minimum for industrial safety.
- Industrial safety involves the detection, mitigation, management, and prevention of workplace hazards to protect against accidental death, injury, property damage, or interruption of production. The operating philosophy at SRS is that the safety and health of employees is the first and utmost priority. Procedure Manual 4Q, Industrial Hygiene [28] defines basic site-wide industrial safety policies and minimum requirements.
- During facility operation, several programs ensure timely identification of industrial hazards. Examples of these programs include OSHA compliance reviews, routine safety audits and periodic safety inspections, incident investigations, annual safety program review, monthly safety meetings, safety suggestion programs, and the SRS Quality Assurance program.

5.1.1.2 Hazard Assessment

The hazard assessment provides the detailed information that allows the development of specific events and scenarios associated with hazardous material releases and the identification of controls to prevent or mitigate these releases.

The primary goal of the hazard assessment is to select events that can result in uncontrolled releases to the onsite or offsite populations or to the environment. These events or accidents are caused by an uncontrolled release or transfer of energy that results in human or programmatic impacts (i.e., injury to personnel, damage to property, and disruption or degradation of an activity of interest). Potential events that can result in uncontrolled releases of energy are analyzed based on the physical configuration of the facility, the environment in which the operation takes place, and the operating experience of similar systems or components. Credible single events and failures are postulated that result in energy sources being released, including natural forces, equipment malfunctions or failures, procedural errors, and human errors.

For this Hazard Assessment, the hazard assessment tables were modified to place emphasis on the identification of the hazards relating to the ETP process and the controls to detect, prevent, or mitigate these hazards. Risk assessment for each potential event was not required since the highest consequence for the ETP was determined to be a minor facility impact. Therefore, frequency and consequence evaluations were not considered in the hazard assessment table. The hazard assessment is presented in a separate engineering calculation [36] and includes the following information:

- Event Number
- Event Category
- Postulated Event Description
- Causes
- Preventive Features
- Mitigative Features
- Method of Detection

The information categorized in the hazard assessment is described in the following subsections.

EVENT NUMBER

Events are numbered to provide each with a sequential reference.

EVENT CATEGORY

Events are categorized according to the nature of the postulated release mechanism. A standard list of event categories is used. They are as follows:

- E-1 - Fire
- E-2 - Explosion
- E-3 - Loss of Containment/Confinement
- E-4 - Direct Radiological/Chemical Exposure
- E-5 - Nuclear Criticality
- E-6 - External Hazards
- E-7 - Natural Phenomena

Events are categorized according to the event description rather than the event cause. For example, a facility fire might be a postulated event that is caused by an earthquake or some other natural phenomena. This event would fall under category E-1 (Fire) rather than E-7 (Natural Phenomena).

POSTULATED EVENT DESCRIPTION

A brief description of a postulated event is given in this column of the Hazard Assessment Tables.

The event description clearly defines the nature of the event. It includes the type of event, its location, hazard source, affected system(s) or equipment, any interaction with other facility section(s), system(s), equipment, and or hazards, and any pertinent operating characteristics.

CAUSES

The root causes of the postulated event are listed. A cause specifically states the failure, error, operational, and/or environmental condition that initiated the release event. The Hazard Identification Tables are used as a guide in developing specific causes for release events.

PREVENTIVE FEATURES

A preventive feature is any feature that could readily be expected to act to prevent the release of hazardous material to an unwanted location. The selection of such features is made without regard to any possible pedigree of the feature such as procurement level or current classification. These might include engineered features (e.g. structures, systems, components, etc.), administrative controls (e.g. procedures, policies, programs, etc.), natural phenomena (e.g. ambient conditions, buoyancy, gravity, etc.), or inherent features (e.g. physical or chemical properties, location, elevation, etc.) operating individually or in combination. Preventive features are those that are assumed to be operable prior to an event and are not required to be operable during the event or post event. The Hazard Assessment Tables are formatted such that a distinction is made between administrative and design features.

MITIGATIVE FEATURES

Mitigative features are any features that are readily expected to act to reduce the consequences associated with the release of hazardous material to an unwanted location for a particular event. The identification of such features is made without regard to any possible pedigree of the feature such as procurement level or current classification. These features are not required to maintain the facility hazard classification of the ETP. Mitigative features are assumed to be operable during an event or after an event, but are not required to be operable prior to the event. Therefore, mitigative features must be capable of withstanding the environment of the event. These might include engineered features (e.g. structures, systems, components, etc.), administrative controls (e.g. procedures, policies, programs, etc.), natural phenomena (e.g. ambient conditions, buoyancy, gravity, etc.), or inherent features (e.g. physical or chemical properties, location, elevation, etc.) operating individually or in combination. The Hazard Assessment Tables are formatted such that a distinction is made between administrative and design features.

5.2 HAZARD ASSESSMENT RESULTS

As discussed in Section 5.1, the hazard assessment consists of two basic analytical activities: hazard identification and hazard assessment. This section provides the results of these activities.

5.2.1 HAZARD IDENTIFICATION

As stated in Section 5.1.1, hazards associated with the ETP downgrade were systematically identified by listing hazardous materials, energy sources, and their locations in tables to ensure completeness. A screening was performed to eliminate material/energy types and quantities that are considered "common hazards." Hazard Identification was divided into three steps; 1) division of the facility into "segments," 2) facility information walkdowns, and 3) screening for common hazards.

Facility walkdowns, reviews of existing facility safety documentation and interviews with facility personnel were conducted to identify hazardous materials, both chemical and radiological, as well as hazardous energy sources. The hazard identification tables developed from facility walkdowns are located in Appendix B of this ASA.

5.2.1.1 Division of the ETP

The facility has been divided into 7 segments to facilitate hazard identification and assessment. These segments are based upon physical locations of the various processes and flows of material (both process and waste) in the ETP. These segments are described in Section 1.1 of the ASA.

5.2.1.2 Facility Walkdowns

A walkdown of the ETP was performed with one of the Facility Engineers. The information walkdown also included the process of Hazard Assessment team members reviewing the following documents:

- ETF Process Systems Overview [7, 8]
- ETF Regulatory Compliance and Safety Envelope [9]
- Process Hazards Review F/H-Area Effluent Treatment Facility [10]

5.2.1.3 Screening of Common Hazards

Facility Hazard classification for this facility has been performed and documented in Reference 1. Per Reference 1, the Hazard Baseline Grouping for the ETP is a Radiological Facility for radiological inventory and a Low Hazard chemical facility for chemical inventory.

Since screening for common chemical hazards have been completed for ETP in the Hazard Baseline Downgrade [1], an additional screening was conducted only to address hazardous energy sources during the hazard identification. The Hazard Assessment team screened each identified hazard for each section based on material/energy types and quantities using the guidance and screening criteria provided in Reference 33.

If the identified hazard does not meet the appropriate screening criteria for identification as a common hazard, then the hazard is not considered common and is carried forward to the Hazard Assessment.

5.2.1.4 Results of Hazard Identification

Table B-1, Hazard Identification Table, lists all identified hazards and corresponding locations for each section in the ETP.

5.2.1.5 Radiological Inventory

The radionuclide inventory is based on the sum of each process segments with an approximate mix of the following radionuclide material taken from the Hazard Baseline Downgrade [1]:

Segment #	H-3 (Ci)	*Cs-137 (Ci)	Other B-G (Ci)	Other Alpha, Am-241 (Ci)
1	8.5E+02	*	1.2E+01	3.7E-01
2	2.6E+03	*	1.0E+01	3.1E-01
3	8.5E+02	*	1.2E+01	3.7E-01
4	2.6E+03	*	1.0E+01	3.1E-01
5	5.0E+02	2.4E+00	5.0E+00	2.0E-01

Segment #	H-3 (Ci)	*Cs-137 (Ci)	Other B-G (Ci)	Other Alpha, Am-241 (Ci)
6	2.4E+02	4.0E+00	8.4E+00	3.3E-01
Total	7.6E+03	6.4E+00	5.7E+01	1.9E+00

* Cs-137 content in cooling water/retention basins is bounded by gross beta-gamma values

This inventory is based on liquid activity and therefore does not include Segment 7, which consists of dewatered media removed from Segments 5 and 6.

In this Hazard Assessment, the total maximum radionuclide inventory was released to determine the unmitigated consequence for each segment. No incident was identified that would exceed the on-site or off-site criteria. Since there is no potential risk associated with the airborne release of the entire radionuclide inventory, no further consequence assessment was conducted for the release of each segment inventory.

The inventory of each segment will be administratively controlled to ensure that the total inventory of the single segment does not meet or exceed the Hazard Category 3 threshold limits for each segment. The maximum inventory available for hold up in any segment will be procedurally maintained. Guidelines for developing the inventory control procedures are contained in Attachment 1.

CRITICALITY HAZARD SOURCES

Fissile material will not be present in sufficient quantities to make criticality a credible event (see References 20 and 21). These references demonstrate that there is no credible mechanism and no favorable locations for accumulation of fissile material in the ETP systems. The ETP currently does not require a Fissile Material Inventory Control Program. The ETP Hazard Baseline Classification shall be re-evaluated at a future time if the facility will be required to accept substantially more fissile material due to new missions. A Fissile Material Inventory Control Program may be implemented at a future date.

Criticality caused by an inadvertent transfer from the Tank 50 Valve Box has been determined to be incredible [46]. See section 3.2.2.3 for further discussion of the barriers credited in the Tank 50 Valve Box NCSE.

5.2.1.6 Chemical Inventory

According to the original hazardous chemical screening contained in the EPHA, three (3) potentially toxic chemicals are stored at the ETP. The chemicals are concentrated nitric acid, aluminum nitrate, and ferric nitrate. The current revision of the EPHA [34] noted that all 3 of these chemicals could be screened "from the possibility of exceeding operational emergency limits" on the following bases:

- Nitric acid is controlled administratively at a reduced maximum concentration (64 wt% reduced to 45 wt%).

- Aluminum nitrate (stored as a 60 wt% solution) is an "ingestion hazard and not an inhalation hazard (except as a common irritant dust) and shows no vapor pressure," (therefore having only a small fraction of carryover in vaporizing water).

- Ferric nitrate (to be stored as a 44 wt% solution) for the same reasons as aluminum nitrate.

Additionally, ferric nitrate is not used in the facility, and the system dedicated to its usage has been abandoned in place. The maximum potential inventory of each of these chemicals is 10,000 gallons. The storage tanks and associated piping are constructed to industrial standards. The tanks are located within a diked area large enough to contain the entire spill, assuming the worst-case scenario of tank rupture. The concentrated nitric acid storage tank is periodically inspected for corrosion and structural integrity. Based on toxicological data, no incident was identified that would exceed the on-site criteria of "Immediately Dangerous to Life or Health" or the off-site criteria of Emergency Action Level. AN and FN are ingestion hazards and are not inhalation hazards (except as a common irritant dust). In addition, the hazardous material itself shows no vapor pressure (salt in solution; small fraction of carryover in vaporizing water). Therefore, AN and FN can be screened from further analysis based on them not being a toxic inhalation substance and having very low vapor pressure. Nitric acid, at the concentration stored at ETP, is classified as a common industrial hazard for which national consensus codes and standards exist to guide safe design and operation. No further analysis of ETP chemicals will be performed in this ASA beyond a brief mention of several other chemicals of possible concern as noted below:

- Caustic is used at ETP for chemical cleaning and pH adjustment in concentrations and quantities low enough to be classified as common industrial hazards.

- Oxalic acid is utilized for various cleaning applications at ETP, primarily in a batch process for cleaning the Norton or RO filters. Solid (powdered) Oxalic acid is manually added to the cleaning mix tank in the compressor room. IH has monitored Oxalic acid dust and determined that the exposure received does **NOT** exceed exposure limits, therefore no mask is required. However, the operator may wear a mask as a personal preference.

- Mercury is present in trace quantities in ETP wastewater. The mercury is concentrated in the mercury removal columns, but is chemically bound by the ion exchange resins therefore presenting no hazard to the public, or the environment. Mercury vapor may be present if the resin is allowed to dry during removal from the vessel and during any subsequent operations or maintenance activities.

- Dimethyl mercury (DMHg) vapors have been detected in the F and H area process influent streams which pass through the process sewers, lift stations, force mains, and Wastewater Collection Tanks of the ETP. These vapors have been noted primarily at the process sewer manholes, ETP Lift Station exhaust fans, and the OR Mercury Removal area sump. Dispersion stacks have been installed on the two lift station exhaust fans, and have been successful in reducing concentrations below levels of concern at that location. Industrial Hygiene personnel are present to monitor personnel exposure during any operation that may cause DMHg vapor release from the process stream.

Additional chemicals which may be present in the ETP wastewater include, but are not limited to, aniline, benzene, and compounds of barium, beryllium, chromium, copper, lead, nickel, sodium, zirconium, etc. Feed limits have been defined for the chemicals anticipated to be present in the wastewater [11]. These limits are based on the ETP Wastewater Permits, ETP operations, Saltstone WAC [24], Tank Farm WAC [45], and South Carolina Water Quality Criteria.

5.2.2 HAZARD ASSESSMENT

Based on the hazard identification process described in Section 5.1.1.1, the potential events associated with the ETP radiological/chemical hazards were identified in the Hazard Assessment Tables in Reference 36. Note that the table does not identify the events associated with the ETP Industrial Hazards. These events are documented in Reference 32. The Hazard Assessment Tables [36] lists all identified potential events, causes, preventive and mitigative features, and method of detection.

No operator actions or equipment were assumed in developing the consequences. Consequences of these events were analyzed and discussed as shown below.

Since the risk of the consequence is acceptable, no further in-depth analysis using more sophisticated and quantitative techniques was performed.

5.2.2.1 Radiological Hazards Analysis for ETP

Radiological consequences were estimated using the ETF Hazard Baseline Downgrade Document [1]. The ETP was classified as a Radiological facility. This means the facility will not meet the threshold for Hazard Category 3. The values for radionuclides at the Hazard Category 3 threshold point represent levels of material which, if released, would produce less than 10 rem doses at 30 meters based on a 24 hour exposure [3]. Assuming the entire inventory for any one segment of the ETP was at risk from a particular release scenario, the resultant dose would be less than 10 rem. Therefore, all radiological releases postulated to occur from the ETP were conservatively assumed to have a low or negligible consequence. Radiological contamination cases postulated to occur were qualitatively judged to result in a negligible consequence.

5.2.2.2 Chemical Hazards Analysis for ETP

The ETP is classified as a Low Hazard Chemical Facility because it does not store or use any hazardous chemicals at quantities exceeding the threshold limits of a Low Hazard Chemical Facility [1]. The comparison of the chemical inventory to the RQs, TPQs, and TQs is provided in Table A-1 of Appendix A. RQs (Reportable Quantities) per 40 CFR 302.4 and 29 CFR 1910.120 are included for informational purposes only. Exceeding a RQ has no impact on the facility's Chemical Hazard Classification, however spills in excess of the RQ are reportable to State and Federal authorities. TPQs and TQs refer to quantities of hazardous chemicals requiring process safety and risk management, and emergency planning per 29 CFR 1910.119, and 40 CFR 68 and 355.

The chemical inventory at ETP includes those chemicals that are used to treat process wastewater. Any process chemicals brought into the facility in the future must meet the requirements specified in Section 3.2.3.2 of this ASA.

In addition, the only possible significant source term generation mechanisms that could remotely affect the chemicals stored in storage tanks would be high-velocity winds from straight winds or a tornado, an earthquake, or an aircraft crash. However, even if the entire chemical inventory could be released, the dispersion characteristics of high-velocity winds are very large, such that no onsite consequences would be reported and the offsite consequences would be insignificant. There could be a fire after an aircraft crash, however, the release would be negligible since there are a limited amount of combustible materials present. Given a release of the entire chemical inventory due to a seismic event, the dikes will contain the spill; thereby, mitigating liquid runoff or ground releases.

There is no other significant high-energy release mechanism that could generate a chemical source term that could produce onsite or offsite chemical consequences of any significance as documented in Reference 34.

5.3 HAZARD ASSESSMENT CONCLUSIONS

A comprehensive review of potential events associated with the ETP was performed. To determine the risks of potential accident scenarios, a Hazards Assessment was performed. Because of the limited energy sources in the ETP exposure mechanisms of the inventories are very limited. Based upon this analysis, the highest consequence classification for the ETP was determined to be a low consequence to the proximate worker. This Hazard Assessment demonstrates that the ETP can be operated without undue risk to onsite or offsite populations or to the environment.

6.0 ASA MAINTENANCE

6.1 MANAGEMENT OF SAFETY BASIS CHANGES

This ASA shall be maintained so as to accurately reflect the state of the ETP and its existing hazards. The nature and extent of physical changes which are anticipated to occur at the ETP shall be evaluated against this ASA. New or revised hazards shall be documented and the measures to prevent or mitigate these hazards shall be implemented prior to implementing the change. The Management of Safety Basis process, as outlined in WSRC Manual 11Q [2], Procedure 1.07 or other Division approved process, should be used to ensure that the safety basis represented in the ASA is maintained throughout the life of the facility and that all changes are evaluated and controlled which might:

- Increase the risk from a hazard to the workers and/or public beyond that previously analyzed, evaluated, and documented in the current document;
- Reduce the reliability or effectiveness of features, controls, procedures, or processes used to mitigate hazards;
- Introduce a new hazard; or reflect new information on existing hazards beyond that currently documented.

The MSB Screening and Evaluation processes should be performed and documented, utilizing Attachments 1, 2, and 3 of WSRC Manual 11Q, Procedure 1.07 or other Division approved process, for all discoveries and proposed activities. Screenings and evaluations may be performed, or reviewed, by those individuals specified on the documented MSB qualification roster. Copies of the evaluations should be provided to organizations responsible for other applicable hazard, safety and environmental analyses (e.g., JHAs, PHRs, WCPs, RWPs, NEPA checklists, etc.) to ensure consistency. This ASA along with the screenings/evaluations should be maintained in accordance with WSRC Manual 1Q [30].

6.2 ANNUAL REVIEW OF ASA

An annual review shall be performed and documented to determine the need for an update to this ASA. The need for an update will be determined based upon the degree of change in the facility and/or methodologies since the last update.

6.3 ASA CHANGE CONTROL

Existing procedures should be used to the greatest extent possible to manage and control safety basis changes. Design/hardware changes should be initiated and processed in accordance with WSRC Manual E7 [35].. Procedure changes should be initiated and processed in accordance with WSRC Manual 2S [29].. All safety basis changes should be submitted to organizations or programs that may be impacted by such changes. For example, safety basis changes such as material inventories can impact EPHAs or FHAs, hence such changes will be submitted to organizations responsible for Emergency Management Plan or Fire Protection Program. Also, changes in the content of materials processed in one facility and subsequently transferred to another facility can affect the safety of both facilities. Therefore, the acceptability of such changes must be approved by both the sending and receiving organizations.

6.4 ASA APPROVAL PROCESS

Review and approval of this ASA will be conducted in a formal manner. The ASA and all revisions shall be reviewed and approved by the ETP Facility Operations Safety Committee. The LWDP Chief Engineer and ETP Project Manager shall provide the minimum essential approval of this ASA in accordance with WSRC Manual 11Q [2]. The approval of changes to hazard baseline documentation should be at least to the same level as the original approval (unless the classification has been changed).

6.4.1 Development Methodology for the ETF (ETP) ASA

Guidance for the development of an Auditable Safety Analysis is minimal, with the governing documents being DOE EM-STD-5502-94 [4] and Manual WSRC 11Q [2]. The fundamental direction given therein is simply to conduct and document a systematic analysis of hazards. Format and content are not specified. This ASA was developed initially following the guidelines for a Health and Safety Program set forth by Manual WSRC 20Q, "Health and Safety Manual for Hazardous Waste Operations". This was subsequently deemed to exceed the needs for the ETF (ETP) and thus the ASA was reworked to its current form.

The method employed for the ASA development included analyst research, but most importantly involved significant interaction with facility and SW Division personnel. Several team meetings were held to derive the Hazards Analysis. That Hazards Analysis spanned common industrial hazards and ETF specific process hazards, and ultimately yielded the Principal controls presented in Section 3.0. The Facility Operations Safety Committee was used extensively to gain facility comment and approval.

Given that the ETP was previously considered a Hazard Category 3 Nuclear Facility, and then proposed for a downgrade to a Radiological Facility [1], significant DOE and SW Division senior management review was utilized. The DOE participated in a number of the team meetings, as well as unique meetings to solicit and address DOE comments. The SWD senior management review was formally conducted and concluded at the Division Safety Committee, chaired by Dr. W. S. J. Kelly, SWD Vice President and General Manager (see SWD-TSD-99-0023, "Solid Waste Division Safety Committee (SWDSC) Minutes of Meeting – February 24, 1999").

The final ASA format and content as presented herein is believed to represent a model for Radiological Facilities, and is being used as a standard to develop a guideline for future ASA development.

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APPENDIX A: INVENTORY TABLE

TABLE A-1, CHEMICAL INVENTORY AND COMPARISON TO THRESHOLD LIMITS

Chemical	SEGMENT 5				SEGMENT 6				RQ	TPQ	TQ	
	WWC Tanks	Acid & Caustic Tanks	DIKED AREA (241-73H)	TOTAL	Treat. Bldg.	Storage Area	Process Chem. Tanks	TOTAL			OSHA PSM	EPA RMP
Mercury	7.34E+03g	-	-	7.34E+03g	5.79E+03g	-	-	**5.79E+03g**	4.54E+02g	NL	NL	NL
Lead	4.41E+02g	-	-	**4.41E+02g**	3.39E+02g	-	-	**3.39E+02g**	4.54E+03g	NL	NL	NL
Ammonia	5.51E+04g	-	-	**5.51E+04g**	5.85E+04g	-	-	**5.85E+04g**	4.54E+04g	2.27E+05g	4.54E+06g	NL
Nitric Acid	-	3.68E+07g	-	**3.68E+07g**	-	4.06E+05g	1.42E+07g	**1.46E+07g**	NL	NL	NL	NL
Oxalic Acid	-	-	-	-	-	1.14E+07g	-	**1.14E+07g**	NL	NL	NL	NL
Sodium Hydroxide	-	4.07E+07g	-	**4.07E+07g**	-	3.02E+05g	2.81E+06g	**3.11E+06g**	4.54E+05g	NL	NL	NL
Aluminum Nitrate	-	-	10,000 gallons	**10,000 gallons**	-	-	-	-	NL	NL	NL	NL
Ferric Nitrate*	-	-	10,000 gallons	**10,000 gallons**	-	-	-	-	1,000 lbs	NL	NL	NL

*Ferric Nitrate is not currently in use in the facility, and handling capability for the chemical has been abandoned in place.

APPENDIX B: HAZARD IDENTIFICATION TABLES

Table B- 1, ETF Hazard Identification Worksheet (1 of 8)

Location and Task	Hazard Energy Sources and Materials																																				
	Physiochemical											Chemically Toxic						Biological				Open Flame					Potential						Kinetic				
	Combustible Materials	Corrosive	Explosive	Flammable	Oxygen Deficient	Oxygen Rich	Pyrophoric (Pu, U metal, etc.)	Reactive	SC* (Nitric Acid, organics, etc.)	Uncontrolled Chemical Reactions	Other Chem Add, Truck Unloading	Absorption	Carcinogen	Contact	Ingestion	Inhalation	Other	Etiologic Agents (Disease)	Plants (Poison ivy/oak, etc.)	Wildlife (Snakes, insects, etc.)	Other	Bunsen Burners	Gas Welding	Pilot Lights	Torches	Other	Gas Bottles	Gas Receivers	Pressure Vessels	Steam Headers/Lines	Suspended Equipment\Materials	Other	Fans	Motors	Pumps	Rotating Machinery	Other
Segment 1																																					
Cooling Water Basin F	X			X	X													X	X	X														X	X	X	
Segment 2																																					
Retention Basin F					X													X	X	X														X	X	X	
Segment 3																																					
Cooling Water Basin H	X			X	X													X	X	X														X	X	X	
Segment 4																																					
Retention Basin H					X													X	X	X														X	X	X	

X = Refers to the hazards considered applicable

FOOTNOTES:

*SC - Spontaneous Combustion

Table B-1. ETF Hazard Identification Worksheet (2 of 8)

Location and Task	Hazard Energy Sources and Materials																																						
	Rad. Matl.				Hazardous Material								Physical															Electrical											
	Fissile Material	Non-Ionizing Radiation	Radiological Material	Other	Alkali Metals	Asphyxiants	Biological	Carcinogens	Corrosives	Oxidizers	Toxics	Other - Resin	Confined Space Entry	Crane	Elevator Work	Falling/Tripping (Debris, holes, etc.)	Heat	Heavy Equipment	Heavy Lifting	Ladders/Scaffolding	Noise	Power Tool Operation	Remote Area	Severe Weather (Lightning, etc.)	Truck/Car	Non-Facility Event	Other - Drowning	Batteries	Cable Runs	Electrical Equipment	Generation Equipment	Heaters	High Voltage	Power Tools	Switchgear	Transformers	Underground/In-slab Wiring	Wiring	Other - Diesel
Segment 1																																							
Cooling Water Basin F			X				X						X			X	X		X	X	X	X	X	X	X		X		X	X				X				X	
Segment 2																																							
Retention Basin F			X				X						X			X	X		X	X	X	X	X	X	X		X		X	X			X	X	X	X		X	
Segment 3																																							
Cooling Water Basin H			X				X					X	X			X	X		X	X	X	X	X	X	X		X		X	X				X				X	
Segment 4																																							
Retention Basin H			X				X						X			X	X		X	X	X	X	X	X	X		X		X	X			X	X	X	X		X	

X = Refers to the hazards considered applicable

FOOTNOTES:

Table B-1. ETF Hazard Identification Worksheet (3 of 8)

Location and Task	Hazard Energy Sources and Materials: Physiochemical											Chemically Toxic						Biological				Open Flame					Potential						Kinetic				
	Combustible Materials	Corrosive	Explosive	Flammable	Oxygen Deficient	Oxygen Rich	Pyrophoric (Pu, U metal, etc.)	Reactive	SC* (Nitric Acid, organics, etc.)	Uncontrolled Chemical Reactions	Other Chem Add, Truck Unloading	Absorption	Carcinogen	Contact	Ingestion	Inhalation	Other	Etiologic Agents (Disease)	Plants (Poison ivy/oak, etc.)	Wildlife (Snakes, insects, etc.)	Other	Bunsen Burners	Gas Welding	Pilot Lights	Torches	Other	Gas Bottles	Gas Receivers	Pressure Vessels	Steam Headers/Lines	Suspended Equipment\Materials	Other	Fans	Motors	Pumps	Rotating Machinery	Other
Segment 5																																					
Process Sewer F		X				X										X		X	X	X			X														
Process Sewer H		X				X										X		X	X	X			X														
Lift Station F		X				X										X		X	X	X			X											X	X	X	
Lift Station H		X				X										X		X	X	X			X											X	X	X	
Force Main		X				X										X		X	X	X			X														
Waste Water Coll. Tanks		X				X												X		X			X											X	X	X	
OR Hg Columns		X				X						X	X			X				X			X						X		X						
Carbon Columns						X					X									X			X						X		X			X	X	X	
Acid & Caustic Storage AN		X				X		X	X	X	X			X		X				X			X							X	X			X	X	X	

X = Refers to the hazards considered applicable

FOOTNOTES:

*SC - Spontaneous Combustion

Table B-1. ETF Hazard Identification Worksheet (4 of 8)

Location and Task	Hazard Energy Sources and Materials: Rad. Matl.				Hazardous Material								Physical															Electrical											
	Fissile Material	Non-Ionizing Radiation	Radiological Material	Other	Alkali Metals	Asphyxiants	Biological	Carcinogens	Corrosives	Oxidizers	Toxics	Other - Resin	Confined Space Entry	Crane	Elevator Work	Falling/Tripping (Debris, holes,	Heat	Heavy Equipment	Heavy Lifting	Ladders/Scaffolding	Noise	Power Tool Operation	Remote Area	Severe Weather (Lightning, etc.)	Truck/Car	Non-Facility Event	Other - Drowning	Batteries	Cable Runs	Electrical Equipment	Generation Equipment	Heaters	High Voltage	Power Tools	Switchgear	Transformers	Underground/In-slab Wiring	Wiring	Other - Diesel
Segment 5																																							
Lift Station F			X				X						X			X	X			X	X	X	X	X	X			X	X	X	X		X	X	X	X	X	X	X
Lift Station H			X				X						X			X	X			X	X	X	X	X	X			X	X	X	X		X	X	X	X	X	X	X
Force Main			X				X						X			X	X			X		X	X	X	X									X				X	
Waste Water Collection			X				X						X			X	X			X		X		X	X				X					X				X	
OR Hg Columns			X						X			X	X			X	X			X		X		X	X				X					X				X	
Carbon Columns			X										X	X		X	X			X		X		X	X				X					X				X	
Acid & Caustic Storage AN									X	X	X		X			X	X			X		X		X	X				X			X		X				X	

X = Refers to the hazards considered applicable

FOOTNOTES:

Table B-1. ETF Hazard Identification Worksheet (5 of 8)

Location and Task	Hazard Energy Sources and Materials																																					
	Physiochemical											Chemically Toxic						Biological				Open Flame					Potential						Kinetic					
	Combustible Materials	Corrosive	Explosive	Flammable	Oxygen Deficient	Oxygen Rich	Pyrophoric (Pu, U metal, etc.)	Reactive	SC* (Nitric Acid, organics, etc.)	Uncontrolled Chemical	Other	Absorption	Carcinogen	Contact	Ingestion	Inhalation	Other	Etiologic Agents (Disease)	Plants (Poison ivy/oak, etc.)	Wildlife (Snakes, insects, etc.)	Other	Bunsen Burners	Gas Welding	Pilot Lights	Torches	Other	Gas Bottles	Gas Receivers	Pressure Vessels	Steam Headers/Lines	Suspended Equipment\Materials	Other	Fans	Motors	Pumps	Rotating Machinery	Other
Segment 6																																						
pH Adjust. System		1			X				X	X				X	X								X								X			X		X	
Filtration System		1			X									X									X							X	X			X	X	X	
Reverse Osmosis System		1												X		X		X					X						X		X		X	X	X	X	
Evaporation System		1			X									X									X						X	X	X			X	X	X	
Ion Exchange System		1			X												2						X						X		X			X	X	X	
Process Chemical Tanks		1			X			X		X				X	X	X							X						X	X				X	X	X	
Control Building	X	X		X																			X				X			X			X	X	X	X	
Treated Water System					X															X			X								X			X	X	X	
Treated Water Outfalls																			X	X																	

X = Refers to the hazards considered applicable

FOOTNOTES:

*SC - Spontaneous Combustion

1 - Nitric Acid / Caustic

2 – Resins

Table B-1. ETF Hazard Identification Worksheet (6 of 8)

Location and Task	Hazard Energy Sources and Materials: Rad. Matl.				Hazardous Material								Physical															Electrical											
	Fissile Material	Non-Ionizing Radiation	Radiological Material	Other	Alkali Metals	Asphyxiants	Biological	Carcinogens	Corrosives	Oxidizers	Toxics	Other	Confined Space Entry	Crane	Elevator Work	Falling/Tripping (Debris, holes,	Heat	Heavy Equipment	Heavy Lifting	Ladders/Scaffolding	Noise	Power Tool Operation	Remote Area	Severe Weather (Lightning, etc.)	Truck/Car	Non-Facility Event	Other	Batteries	Cable Runs	Electrical Equipment	Generation Equipment	Heaters	High Voltage	Power Tools	Switchgear	Transformers	Underground/In-slab Wiring	Wiring	Other - Diesel
Segment 6																																							
pH Adjust. System			X						1	1			X			X	X			X		X							X				X	X				X	
Filtration System			X				X		1				X			X				X		X							X				X	X				X	
Reverse Osmosis System			X				X		1	1			X			X	X			X		X		X					X					X				X	
Evaporation System			X						1	1			X			X	X			X	X	X		X					X					X				X	
Ion Exchange System			X						1				X			X	X			X		X		X					X					X				X	
Process Chemical Tanks									1	1	X		X			X	X			X		X		X					X					X				X	
Control Building			X						X	X						X				X		X						X	X	X	X	X	X	X	X	X	X	X	X
Treated Water System			X										X			X	X			X		X		X					X					X					
Treated Water Outfalls			X													X	X			X		X	X	X	X									X					

X = Refers to the hazards considered applicable

FOOTNOTES

1 = Nitric Acid/ Caustic, AN

Table B-1. ETF Hazard Identification Worksheet (7 of 8)

Location and Task	Hazard Energy Sources and Materials																																				
	Physiochemical											Chemically Toxic						Biological				Open Flame					Potential						Kinetic				
	Combustible Materials	Corrosive	Explosive	Flammable	Oxygen Deficient	Oxygen Rich	Pyrophoric (Pu, U metal, etc.)	Reactive	SC* (Nitric Acid, organics, etc.)	Uncontrolled Chemical	Other	Absorption	Carcinogen	Contact	Ingestion	Inhalation	Other	Etiologic Agents (Disease)	Plants (Poison ivy/oak, etc.)	Wildlife (Snakes, insects, etc.)	Other	Bunsen Burners	Gas Welding	Pilot Lights	Torches	Other	Gas Bottles	Gas Receivers	Pressure Vessels	Steam Headers/Lines	Suspended Equipment\Materials	Other	Fans	Motors	Pumps	Rotating Machinery	Other
Segment 7																																					
Waste Storage Area	X	X		X								X				X				X									X								

Table B-1. ETF Hazard Identification Worksheet (8 of 8)

Location and Task	Hazard Energy Sources and Materials																																						
	Rad. Matl.				Hazardous Material								Physical															Electrical											
	Fissile Material	Non-Ionizing Radiation	Radiological Material	Other	Alkali Metals	Asphyxiants	Biological	Carcinogens	Corrosives	Oxidizers	Toxics	Other-Resin	Confined Space Entry	Crane	Elevator Work	Falling/Tripping (Debris, holes,	Heat	Heavy Equipment	Heavy Lifting	Ladders/Scaffolding	Noise	Power Tool Operation	Remote Area	Severe Weather (Lightning, etc.)	Truck/Car	Non-Facility Event	Other	Batteries	Cable Runs	Electrical Equipment	Generation Equipment	Heaters	High Voltage	Power Tools	Switchgear	Transformers	Underground/In-slab Wiring	Wiring	Other
Segment 7																																							
Waste Storage Area			X				X		X			X	X	X			X	X	X	X				X	X														

X = Refers to the hazards considered applicable

ATTACHMENT 1

INVENTORY CONTROL GUIDELINES FOR THE EFFLUENT TREATMENT PROJECT PROCESS

1.0 METHODOLOGY FOR DETERMINING TOTAL INVENTORY POTENTIALLY AVAILABLE FOR HOLDUP

1.1 THEORY AND BACKGROUND

The difference between the incoming and exiting radionuclide inventories will typically provide the maximum inventory potentially available for hold up in the ETP process columns and elsewhere in Segments 5 and 6.

$$D = \Sigma \text{ IN} - \Sigma \text{ OUT}$$

The total incoming radionuclide inventory is composed of the radionuclide inventory of the wastewater in the WWCTs and other influents (added in their entirety to both Segments 5 and 6). The total exiting radionuclide inventory is composed of the radionuclide inventory in the waste concentrate stream to Tank 50 or HDB-8 (subtracted from Segments 5 and 6) and the radionuclide inventory of the spent resin in the mercury removal/cation columns, or carbon in the activated carbon columns which are disposed of in the SWMF. Process columns which are physically disconnected and no longer in service and associated waste packages are stored and accounted for in Segment 7. The radionuclide inventory of the treated water stream is assumed to be 0, except for tritium. Total inventory potentially available for hold up in Segments 5 and 6 over a period of time can therefore be calculated from Equation (1):

(1) $D_5 = \Sigma$ Influent - Σ WCT - Σ Resin, Carbon (removed from segment 5)

<u>or</u>

$D_6 = \Sigma$ Influent - Σ WCT - Σ Resin (removed from segment 6)

As a minimum, the gross alpha and total beta-gamma (beta-gamma - includes Cs-137) radionuclide inventory of the incoming wastewater in the WWCTs, the exiting waste concentrate stream, and the spent resins and activated carbon should be evaluated by ETP Engineering and documented in an Inventory Control Procedure. Since the Cs-137 content in the incoming wastewater has been determined to be bound by the beta-gamma value (beta-gamma = 50% Cs-137 and 50% Sr-90) [42], a separate calculation for this radionuclide is not necessary. However, if separate Cs-137 sample results are available for both incoming and exiting streams, separate calculations may be performed. I-129, due to the minimal concentrations in the liquid streams transferred to ETP for treatment, will be addressed only in its holdup on activated carbon and ion exchange resins.

1.2 CALCULATION OF MAXIMUM AVAILABLE HOLD UP IN SEGMENTS 5 AND 6

A representative sample should be obtained from each WWCT prior to pretreatment of each batch. The sample/ evaluation should be performed and documented at least once per month.

Sample results should be in d/min/ml. Incoming inventory, in curies, may be calculated from Equation (2):

(2) I (alpha) = 1.70E-09 * AInfluent * VInfluent
I (beta-gamma) = 1.70E-09 * BGInfluent * VInfluent

Where:

AInfluent = Actual sample analysis results for alpha radiation in influent wastewater (d/min/ml) **
BGInfluent = Actual sample analysis results for beta gamma radiation in influent wastewater (d/min/ml)**
VInfluent = volume of influent wastewater (gallons)
I = incoming inventory (Curies)
**NOTE: That actual sample analysis results should be utilized to track inventory to eliminate "ghost" curie generation, as use of the error band in the calculations would tend to cancel out.

Occasionally additional inventory may be added directly to the process downstream of the WWCTs, but shall be included in equation (2) above.

A representative sample should likewise be obtained from the waste concentrate stream. Sample results should be in d/min/ml. Exiting waste concentrate inventory, in curies, may be calculated from Equation (3):

(3) E (alpha) = 1.70E-09 * AWC * VWC
E (beta-gamma) = 1.70E-09 * BGWC * VWC

Where:

AWC = Actual sample analysis results for alpha radiation in waste concentrate stream (d/min/ml)
BGWC = Actual sample analysis results for beta gamma radiation in waste concentrate stream (d/min/ml)
VWC = volume of Waste Concentrate transferred from ETP (gallons)
E = exiting waste concentrate inventory (Curies)

2.0 METHODOLOGY FOR MONITORING TOTAL RADIONUCLIDE INVENTORY

The total radionuclide inventory in Segments 5, 6 and 7 should be evaluated by ETP Engineering and documented in an Inventory Control Procedure, at least once per month, to ensure that increases in hold-up inventory do not cause Segment 5, 6 or 7 to exceed the Category 3 Threshold Values. A baseline radionuclide inventory for Segments 5, 6 and 7 must be established. This baseline will include the radionuclide inventory in all the process tanks and piping at WAC limits as defined in Reference 1, or bounding levels, as determined by historical sample analyses, and the initial radionuclide inventory held up in the mercury removal columns, cation columns, and carbon columns based on sample results and "process knowledge" [43].

Separate running totals of the radionuclide inventory in Segments 5, 6 and 7 will be maintained for alpha, beta-gamma, tritium, and I-129 on resin and carbon columns. The I-129 holdup will be determined, based on length of time in service and actual sample analyses of vessels removed from service, or calculated using bounding influent concentrations and volumes [43].

2.1 TOTAL RADIONUCLIDE INVENTORY IN SEGMENT 5

The total radionuclide inventory in Segment 5 may be calculated from Equation (4)

(4) T_5 (alpha) = [D_5 (alpha) + B_5 (alpha)] + R_5 (alpha)
Note: [$D_5 + B_5$] must be ≥ 0

T_5 (beta/gamma) =[D_5 (beta/gamma) + B_5 (beta/gamma)] + R_5 (beta/gamma)
Note: [$D_5 + B_5$] must be ≥ 0

T_5 (I129) = B_5 (I129) - W_5(I129)

T_5 (H3) = R_5 (H3), there is no tritium holdup, tritium is not filtered or ion exchanged and passes through the segment.

Where:
R_5 = *radionuclide inventory in all Segment 5 process tanks and piping at WAC limits or* bounding levels [5]
B_5 = radionuclide inventory held up in the Segment 5 OR mercury removal and carbon columns (initially or from previous inventory)
D_5 = Total inventory available for hold up in Segment 5 from WWCTs (Equation 1)
T_5 = total radionuclide inventory in Segment 5
W_5 = total radionuclide inventory physically removed from Segment 5 during the period

2.2 TOTAL RADIONUCLIDE INVENTORY IN SEGMENT 6

The total radionuclide inventory in Segment 6 may be calculated from Equation (5)

(5) T_6 (alpha) = [D_6 (alpha) + B_6 (alpha] + R_6 (alpha)
Note: [$D_6 + B_6$] must be ≥ 0

T_6 (beta/gamma) = [D_6 (beta/gamma) + B_6 (beta/gamma] + R_6 (beta/gamma)
Note: [$D_6 + B_6$] must be ≥ 0

T_6 (I129) = B_6 (I129) - W_6(I129)

T_6 (H3) = R_6 (H3)

Where:
R_6 = radionuclide inventory in all Segment 6 process tanks and piping at WAC limits or bounding levels
B_6 = radionuclide inventory held up in the Segment 6 IX mercury removal columns and cation columns (initially or from previous inventory)
D_6 = Total inventory potentially available for hold up in Segment 6 (Equation 1)
T_6 = total radionuclide inventory in Segment 6
W_6 = total radionuclide inventory physically removed from Segment 6 during the period

2.3 TOTAL RADIONUCLIDE INVENTORY IN SEGMENT 7

The total radionuclide inventory in Segment 7 may be calculated as follows:

(6) T_7 (alpha) = B_7 (alpha) + W_7 (alpha) – S_7 (alpha)

T_7 (beta/gamma) = B_7 (beta/gamma) + W_7 (beta/gamma) - S_7 (beta/gamma)

T_7 (I129) = B_7 (I129) + W_7 (I129) – S_7 (I129)

T_7 (H3) = B_7 (H3) + W_7 (H3) - S_7 (H3)

Where:
B_7 = initial radionuclide inventory in Segment 7
W_7 = radionuclide inventory placed in Segment 7
T_7 = total radionuclide inventory in Segment 7
S_7 = total radionuclide inventory physically removed from Segment 7 during the period

3.0 *THE SUM OF THE FRACTIONS METHODOLOGY*

The Sum of the Fractions Methodology as defined in Reference 1, should be utilized in order to monitor the total radionuclide inventory to ensure that the Category 3 threshold limit values are not exceeded. Each month, the total inventory potentially available for hold up in Segments 5 and 6 and the total radionuclide inventory should be evaluated by ETP Engineering and documented in an inventory control procedure. The sum of the fractions may be calculated from Equations (7) through (9). The appropriate beta-gamma and alpha threshold limits for comparison were selected based on actual sample analysis and References 42 and 3. The selection of Am-241, and Cs-137 and Sr-90 (50:50 ratio assumed in beta-gamma) as bounding radionuclides for alpha and beta-gamma appears to be justified based on earlier carbon column sample results obtained from SRTC and the GEL Laboratory in Charleston, SC. The selection of bounding radionuclides for beta-gamma is justified by Reference 42, and assumptions made in the referenced calculation will be verified annually. Due to the significant buildup of I-129, determined through analysis of spent resin and carbon samples, the periodic contribution (holdup) will be calculated as noted in Section 2.0 and incorporated into the respective segment inventories.

(7) P_5 = 100 * [T_5 (alpha)/5.2E-01 Ci + T_5 (beta/gamma)/2.526E+01 Ci + T_5 (H3)/1.6E+04Ci + T_5 (I129)/6E-02 Ci]

(8) P_6 = 100 * [T_6 (alpha)/5.2E-01 Ci + T_6 (beta/gamma)/2.526E+01 Ci + T_6 (H3)/1.6E+04 Ci + T_6 (I129)/6E-02 Ci]

(9) P_7 = 100 * [T_7 (alpha)/5.2E-01 Ci + T_7 (beta/gamma)/2.526E+01Ci + T_7 (H3)/1.6E+04 Ci + T_7 (I129)/6E-02 Ci]

Where:
P_5 = % of Category 3 threshold limit value in Segment 5
P_6 = % of Category 3 threshold limit value in Segment 6
P_7 = % of Category 3 threshold limit value in Segment 7

In accordance with Reference 19,
$P_5 < 95\%$
AND
$P_6 < 95\%$

Based upon direction from ETP Management, the decision to change out or clean the columns and/or process tanks may be made based on the estimated time for the segment to reach 90% of the Category 3 threshold limits and/or equipment operating life. A new evaluation must be performed to determine the baseline inventory that is held in the process columns and elsewhere in the segments after changing out or cleaning the columns and/or tanks. The evaluation should be performed by ETP Engineering and may be based on sample results, published studies, and process knowledge. The evaluation will be documented in an inventory control procedure. A new running total will be initiated using the new hold up inventory baseline. The use of this method to monitor the process will ensure that increases in hold up inventory do not cause the segment to exceed the Category 3 threshold limit values from Reference 3.